AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 18, NO. 17. WEEKLY. | NEW YORK, THURSDAY, APRIL 25, 1895. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Fast Lathe Work.

By Isaac Chick.

I have often thought that a great part of the time spent in devising new machine tools might be more profitably used in finding out the very best way to use the tools already well known. A common engine lathe, for instance, is perhaps the most common and best known of all the machine tools we have, yet who can safely say that anyone knows all the things that can be well and cheaply done with the engine lathe, or that the very best way for doing any one thing on the engine lathe is surely known now? I use an engine lathe every day of my life, and have worked a long time building engine lathes and small machine tools, and I have seen a great many good and ingenious ways of doing particular jobs on the engine lathe devised and used by my fellow workmen, and I have made some improvements in tools myself, and have sometimes thought I had a particular operation in as good form as I could ever find for it; and yet it has so often happened that I afterward found a way to improve what I thought was the best that could ever be done, that I have about come to the conclusion that nobody can ever be sure he has done more than to find a good way to do a particular job, and that the next man may beat him out and not try very hard either.

Even the most common jobs—pieces of work that I have done thousands of times, but never thought about very much—I often find ways to do both quicker and better than ever before, just by looking carefully after every step of the whole operation. In an ordinary shop, we are very apt to let some things go while we look very sharp after others, and we may keep our faces set so hard and fast in one direction that we cannot see anything that happens outside of one little narrow track right straight ahead of us. The man who tries to cheapen a job wants to look not only straight before him, but on each side as well, and he wants to keep at least one pair of eyes on the back track over which he has already passed, to be sure he knows just what all of his work means.

I don't say this so much because I think I can tell other folks more than they know themselves about what they ought to do, as I say it because I need to remember it myself.

I don't know how many cone pulleys I have turned up in the course of my life—a good many—but all the same I am turning some small cone pulleys just now a little quicker than I ever turned any before, just because I have things in a little better shape than I ever had them before. I have not made any change in the lathe itself; I have not put on any extra tool posts, or guide plates, or anything of the sort; I have just fixed things up so I can handle the cones quickly and easily in and out of the lathe, and so that the lathe will hold the cone in one place, and will turn the arbor and the cone for all that the belt will pull.

There is a good deal in having work driven if you want to push it along quick. I think it is more often the case that the cut has to be a little easy to keep the work from slipping on the arbor than the other way, so that a big cut and coarse feed can be carried right up to the full driving power of the belt without the slipping of the work on the arbor. In fact, I know that I have often used an arbor right along that would not drive up hard in the work, or could not be driven up hard because the work would not stand the hard driving, and so have done the work much more slowly than I could have done it had the drive been all the lathe belt could pull. So I think we can be safe in saying that there is a lot of time lost in doing lathe work on arbors because the work is not held firmly enough on the arbor. If this is true (and I am quite certain most lathe hands will agree with me that long habit of use makes them look on a job on an arbor, as a job that must be humored and coaxed through the best way possible, long time or short time, just as the arbor happens to drive) then there must be a great deal more time lost in lathe work because the arbor does not hold as much as the belt can drive, than either foremen or workmen think about. This is one of the uses of having eyes to look back, so that we can see clearly the real faults in our past work. We get so used to doing one thing one way, that we are ready to call any man a faultfinder if he hints that there even could be a better way than the way we have always used. In some shops the expression is very often heard, "We don't do that way here," and I have noticed that in those shops that are so sure everything is done just right there, there isn't much "rush"; they just fall back on quality of work. In some other shops, where they ask for quantity as well as quality, you don't hear much about "the way we do here," because the "way we do here" changes pretty often in any shop which looks sharp after the first cost of things.

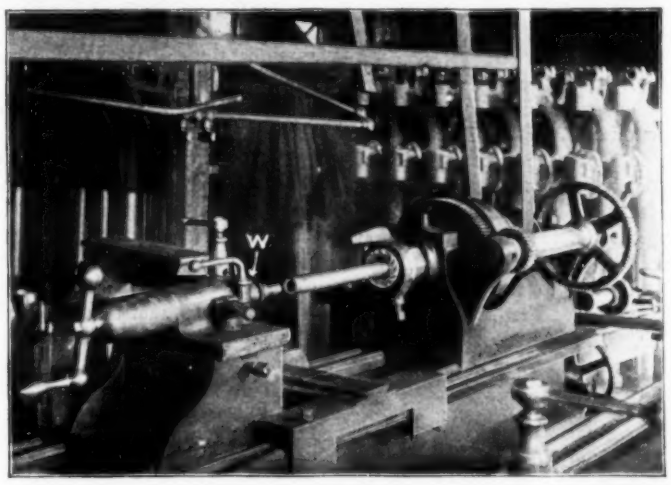


Fig. 1.

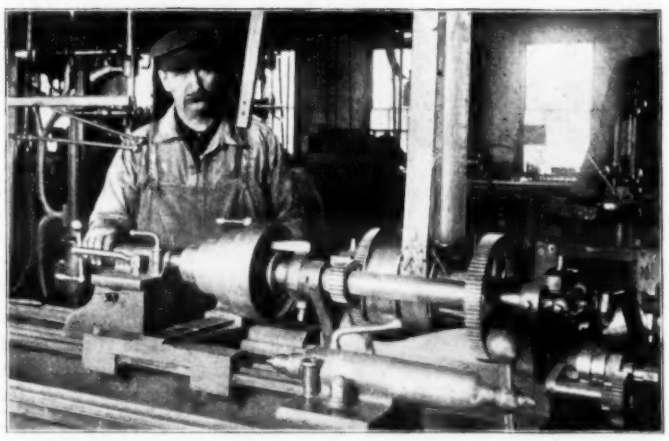


Fig. 2.

Fig. 3.

Fig. 4.

FAST LATHE WORK.

But I was saying that it is hard to hold work on a driven arbor when the arbor is solid, and I have about concluded that there is no expanding arbor on which work can be placed twice alike; with a very nicely made expanding arbor made of one shell on a taper body, and just one split in the shell, work will come pretty nearly true, and can be taken off the arbor and put back so as to run only a very little out; but it does always run out a shade, and if a piece of work wants to be pretty nearly true, it just calls for a solid arbor, and that solid arbor has got to be ground up pretty often to keep it anywhere near right. And it must be a soft arbor if it is going to be put into crooked holes and left there any length of time. If a hard arbor is left in a crooked hole over night, that arbor will be crooked in the morning, and will stay crooked, too. If the crooks in the hole are not too short, a soft arbor will come back straight after it is driven out of the hole. So I think an arbor should never be hardened over half an inch or an inch at each end for general use. If all the chucked holes going on a certain arbor are drilled and bored, and then reamed by a careful hand, so that the holes will be nearly straight, then a hard arbor is the only right thing. But if the holes are made in a turret head chucking machine, as most holes are made nowadays, they will be crooked; sometimes a little, and sometimes a good deal, but you will have to look through a long day's work to find many that are straight, and so arbors should have soft bodies.

Then another trouble comes up. Good screw or hydraulic arbor presses are not found in every shop, and when it comes to driving an arbor hard with a hand hammer or a sledge, it is pretty easy to get the arbor one, or two, or three thousandths out of the way; in fact, all lathe hands know perfectly well that not once in a hundred trials can an arbor out of the common tool room be put on the centers and found to run dead true.

Because of all these things which we all know but seldom look backward and think about, I am in favor of using almost any-

thing besides a driven arbor for lathe work; if a piece of work is turned on a crooked arbor, it is bound to come out crooked; if the work is going to be crooked, what is the use of all the time and expense put into arbors running on centers and driven into crooked holes, and where is the gain in pounding the arbors into the holes in the work and pounding them out again?

Suppose work is not driven on the arbor at all, just slipped on with the hands, and driven from a driver on the arbor, not driven by friction of the arbor at all, what then? The work will come off a very little crooked probably, but not so much crooked as if the work was turned on a driven arbor, according to my experience.

All of this talk may seem very strange to some lathe hands, who will say at once that nine-tenths of the chucked work made is turned upon driven arbors; if these hands will use their looking-backward eyes for a moment, they will see that none of the work they do on arbors is true, because they will never consent to taking a job off the arbor before the turning is completed; they know that if a piece of work moves on the arbor it never runs quite the same again. This fact makes it quite clear that very little true work is done on arbors. There is, however, a vast amount of *nearly* true work done on the arbor—work that is nearly enough true to serve its purpose well.

I am turning a cone pulley of four steps, 4 inches, 6 inches, 8 inches and 10 inches diameter by 2¾ inches face, crowned in 35 minutes in a common lathe with a single tool, the cones coming to me with holes chucked out ready for turning. Perhaps 35 minutes is not so very swift for a cone of these dimensions, and perhaps such cones could be finished by milling much more rapidly than I am turning them on the little engine lathe shown in the engravings. I have not yet seen a milled cone pulley, however, and I can think of some things which make me think it is perhaps a good deal easier to turn a cone pulley than to mill it, and I am sure that 35 minutes is not very bad time for the job. Fig. 1 shows the arbor and work driver and the tail-stock bearing for the arbor all in place, and shows them so clearly that not much description is needed. It would weaken the arbor very much to fit its driving end to the lathe-spindle center, and if the arbor was made the usual way to go between the lathe centers it would have to be supported on two very small diameters where the points of the centers enter the arbor. That is another point we are so familiar with that we don't think much about it; really we are limited in our lathe production of short work all the time by the weakness of support at the points of the lathe centers.

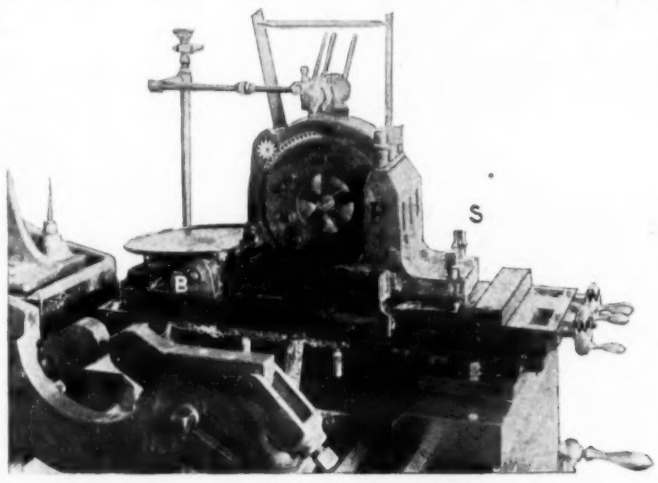


Fig. 5.
Fast Lathe Work.

To avoid weakness at the points of the lathe centers I discard the lathe centers altogether. The head-stock end of the arbor I chuck out and screw on to the nose of the lathe spindle. It will go on and off a great many times without showing any loss of truth. As soon as I have the rough arbor screwed on the nose of the lathe I square off and chuck out the tail-spindle bearing as big as the arbor diameter will allow, and leave plenty of stock around the hole. I then make a special tail-stock center fitted to run in the hollow tail end of the arbor. The body of the arbor I turn exactly sliding fit in the model cone, so that the cone can be slipped on and off in an instant when the tail stock is slipped back out of the way; a large common lathe dog screwed to the large end of the arbor, screwed on the lathe nose with the tail of the dog out, serves to drive the cone slipped on the arbor. The hub of this cone is faced up at the large end only; I therefore give some clearance at the tail-stock end and put a vulcanized fiber washer against a shoulder on the tail center to run against the rough cone hub end and hold all snug endwise. This washer is marked *W* in Fig. 1. All this seems like a very simple rig, and so it is, but see what I gain: I save all time handling the arbor; the arbor stays on the lathe spindle all of the time. I save driving the work on and off the arbor. I save the weak point where the centers enter the arbor, and, best of all, I can drive the cut for all the belt will pull; the back center has a large straight bearing instead of the very small 60-degree cone support in general use, and a felt washer in the arbor at the bottom of the hole can be used to insure a perfect and constant lubrication. I can force this job with this arbor rig up to the limit of the available driving power. The work is slipped on the arbor, and this makes, say, a quarter of a thousandth slack on the arbor, if the cone hole is straight and to size, and so opens the way for a quarter of a thousandth error in the work, but a quarter of a thousandth out is a pretty close limit, and I don't think work done on a slack-fitted arbor is worse than that done on a crooked-driven arbor.

One thing is sure, there is no time wasted in the operations with this arbor.

I have carried out the same idea of screwing arbors on the lathe nose in the handy quick rig for short work shown in Fig. 3. This is a taper spindle *A* with a hub threaded at *B* to fit the nose of the lathe spindle. The taper spindle *A* has a straight thread at its inner end next to the nose hub; this straight thread takes the hubs of the split bushes *C*, *D*, *E*, *F*, which fit *A* internally and any required job externally. Of course *A* should have the greatest possible diameter if utmost production is required. The outer end of *A* can take the tail-stock center or it can fit a straight external or internal tail stock supported bearing. In a manufacturing shop, where internal diameters are duplicated, where duplication is possible, a very few of the expanding shells or bushes will cover a great range of parts. Of course work made on this form of expanding arbor is never quite true. It is, however, fully equal to the work made on any expanding arbor I have ever seen, and averages better than work done on solid arbors generally used. I think I am perfectly safe in saying that work held on the threaded nose of the lathe spindle has a better chance of coming out true than work carried on the lathe centers; the live center of a lathe is true for an instant after it has been trued by careful grinding; no one knows how long it will stay true; every lathe hand does know, however, that it will soon be out of true, and, further, that he will do some crooked work with his untrue live center before he grinds it up again.

Fig. 4 shows my handy shafting turning trap, of which two have been built, one at Reed's lathe shop, where I was working when I built it, and one here, at Snyder's drill shop, Worcester, where the pictures were taken, and whence I now write. This shafting trap consists of a body fitted to slip on the tool post slide of the lathe, where it is held fast with the gib screws in such a position that a plug-setting gauge, which fills the bush carried in a bored seat at the top, this plug gauge being also fitted to the live center, will turn free in the bush *B*. *B* is held from slipping or turning in its seat by the pin *P*. The two bell-crank tool posts *T* are supported on a single stud seated in a bored hub on the frame of the trap, and having two projecting taper ends *S* fitted with nuts. The tool posts *T* have tapered eyes to fit the taper ends of the stud *S*, and can be forced hard on the taper by the nut on the stud thread. The forward reaching tails of the bell-crank tool posts *T* have each a hold-down and a push-up adjusting screw, by which they can be rocked on *S*, so tools carried in mortises and held by screws in *T* can be adjusted in and out.

This is a very simple, cheap thing, also, same as the pulley arbor. It is, however, the very best shaft turning trap I have ever seen. It has not been patented, and it is not for sale.

There are much more elaborate things for the same purpose made here in Worcester; one of them is shown in Fig. 5. In Fig. 5 the bush is not solid, but is composed of five sliders forced in by turning a cam ring outside of the sliding segment adjustable bush by means of the little hand pinion plainly shown. This was patented by Mr. Wood, now an old man, who has been a tool builder for a great many years, and brought out the old Wood & Light lathe, which was the favorite tool maker's lathe for so many years. In Fig. 5 the tool posts *P* are pivoted to sliding blocks *B* adjusted by the screw wheels *W*, *W*, and have also a fine adjustment by the screws *S*. The "Wood" shafting trap was made first, and a great many other tools of the same class have been made. I do not claim any great originality in this tool or for the others I have shown. I do claim great simplicity and certainty of action and convenience in use, for all of the things I show here, which are all of my own design and construction, and all free to the use of any person.

Danger in Delay.

What is worth inventing at all is worth sticking to until it is perfected. This apparent axiom has been enforced upon my mind by an interview with the tele-photo apparatus. For the benefit of those who do not understand that elegant device, I will explain that it is an addition to an ordinary photographic lens, whereby the focal length of the objective may be increased with a corresponding increase in the size of the picture.

At a certain distance from the object a photographic lens will define an image of a certain size. If another lens of longer focus be substituted, the image will be larger.

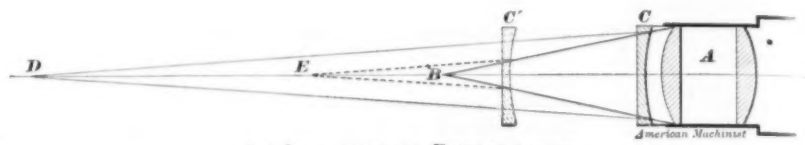
It often happens to the landscape photographer that the particular object he wishes to photograph cannot be approached near enough to secure a picture of desirable size with the lens he ordinarily uses, and his only resource is the substitution of a lens of longer focus. Therefore an ordinary equipment requires the presence of several detached lenses, an arrangement at once expensive and inconvenient.

The tele-photo attachment enables the photographer to vary the focal length of his objective, and thus dispense with all extra lenses.

This invention was announced by a German discoverer, two or three years ago, and immediately awakened a large interest among photographers.

It consists in a concave or dispersing lens back of the ordinary objective, whereby the rays of light which the objective would focalize at a certain point are slightly refracted and meet at another more distant point. The distance of the new point may depend upon the figure of the dispersing lens or upon its position in the cone of light. The latter method is adopted by the manufacturers because it produces a sliding scale of variation.

With a certain disperser the refraction will be constant, and when placed near to the objective in a large beam of light, a certain refraction will focalize the rays at a point more distant than if the disperser is placed further from the objective where the cone of light will be of less diameter.



An Invention in Photography.

This will be made clear by the diagram. *A* is an ordinary photographic objective, the focus of which is at *B*. *C* is a concave lens interposed in the cone of light, slightly refracting the rays and causing them to meet at *D*, and therefore define the image larger than at *B*, as the focal distance *D* is greater than distance *B*. If the lens *C* is moved to *C'* it is apparent with equal refraction the focal point will be at *E*, with a corresponding difference in the size of the image, and so on for all intermediate points of adjustment.

It will be granted that this is a very interesting device, and I think there is no doubt it will prove a very useful one.

The point I wish to enforce, however, is included in the following brief history.

More than ten years ago the thought of it occurred to me. I was a photographer 40 years ago, but was only actively engaged a short time. Therefore things photographic possess a strong interest, and for 20 years I have been engaged in it in a small amateurish way. In some of my dabbling the idea occurred to me that a concave lens would stretch out the focus of an objective. I thought the thing out as well as one could without a knowledge of mathematical optics. I even consulted a professor, but found that in practical application his ability did not reach much beyond my own. Then I sent to Bausche & Lomb and purchased three concave lenses of different curvatures. On receipt of them I put one on the end of a stick and held it in my camera and satisfied myself that the theory would work—then I fell down.

For being very busy in other ways, bread and butter winning, I put off from time to time the fitting up necessary to a real trial with a sensitive plate until long after the discovery abroad was announced. Then I rigged up one of my Bausche & Lomb lenses and did the thing, which, if I had done at once, would have given to me whatever fame or fortune there might have been in the tele-photo, secured by a proper patent.

Mishawaka, Ind. R. D. O. Smith.

American Tools in Switzerland.

I do not think that Americans properly appreciate the really unlimited extent to which our export trade may be enlarged and extended. We have such a wonderful appreciation of our own greatness, and an all-pervading idea that we are quite enough for ourselves within ourselves, but to those who have studied the matter of exportation thoroughly, the fact appears that there lies open to all industries a very large field, which is at present in its infancy, and that is the supplying of the more closely settled and older countries from the unlimited resources of our own.

The Government in issuing the consular reports for April inserts among others, one from our Consul at Zurich, Switzerland, Eugene Germaine, which contains some valuable and interesting information relative to the Swiss market for American tools to be used in the manufacture of furniture and carriages.

In a letter from him, dated February 28,

1895, he says "American woodworking machinery and tools can, I think, be introduced into Switzerland. The furniture, wagon and carriage manufacturers in this country, as well as in many other European countries, are still using old methods to cut, carve, or bend what wood they have to use up to meet their various requirements."

He calls special attention to the fact that is emphasized by so many Americans who are in a position to know the existing needs, and that is "the advantage of a man on the spot who can meet the requirements. If a good, expert agent, able to speak French and German, was sent out to visit the different manufacturers and shops of the country, he could, I am sure, secure large orders."

This necessity for personal work is keenly recognized and followed in our own country, and it would pay us to recognize it in others. You will observe that he lays special stress upon the need of speaking the language of the countries visited, and this point is strongly urged by all Consuls in their reports. We are apt to think that our own tongue is spoken all over the world, but this is not so, and all printed or written matter going to these countries should be in the language spoken in them.

He also calls attention to the fact that "care should be taken, however, to have all such machinery and tools patented in Switzerland, as well as in Germany, to prevent imitations being manufactured from the first models sent out, for it is a well-known fact that German manufacturers make it a practice to imitate our machines and tools, and then cut under our prices."

The importance of American manufacturers keeping themselves in touch with these people is shown by the following extract from the same report: "Mr. J. Geissberger, a carriage manufacturer of this city, desirous of enlarging his plant, requested me to supply him with the addresses of American woodworking machinery factories. I gave him such addresses as I could obtain. He corresponded with several firms, obtained catalogs and price lists, and he now informs me that he is getting ready to order about 25,000 francs ($5,000) worth of machinery from one of two firms in Ohio. He has written for further particulars, requesting, among other things, plans and specifications as to how to set up and place such machinery to advantage, after the receipt of which, he says, he will no doubt order.

"A wagon manufacturer, of Burlington, Iowa, visited this city last summer, and on his rounds dropped into Mr. Geissberger's shops. He succeeded in selling him about $100 worth of wagon and carriage wheels, to be shipped upon his return home. Mr. Geissberger received this trial shipment lately, and is highly pleased with the goods, as to workmanship, quality and price, the cost laid down here being much less than Mr. Geissberger could manufacture them himself.

"It must be remembered that, if shipped in large quantities, much lower freight rates could be obtained, and goods could be laid down at a lower figure than this trial shipment has cost."

This transaction is mentioned to emphasize a fact that woodworking, time-saving machinery, in the manufacture of which the United States excels all other nations, will be wanted in Switzerland as soon as the people are educated to its uses, for they much prefer to manufacture their own wheels, furniture, etc., than to import these articles ready made, if by securing and working the proper machinery, they can do so.

It is reasonable to suppose that in a country with a population of 3,500,000 people, this Mr. Geissberger is but one of the many manufacturers who would gladly avail themselves of our time-saving machinery, if they only knew where to obtain it, and how to work it after it is obtained.

"DUMONT."

ENERGY EQUIVALENTS.

BY EDWARD J. WILLIS.

There frequently occur in the course of engineering work, calculations of efficiency and consumption, which are, more or less, long and tedious. The figures given in following paragraphs will reduce any such calculation to a case of simple multiplication or division. This not only saves time, but greatly decreases the chance of errors, which can often pass unnoticed in many of the rarely understood and complicated expressions which such calculations involve. Only full theoretical values or equivalents are given, and when the delivery is not up to the figure the deficiency is the loss in the transformation, or if the consumption is greater than the equivalent, such excess is the waste of the process. Some of the equivalents are, at the present time, uncertain, and the figures given are subject to such changes as their definite determination will involve. Joule's equivalent has been used as 776, which is considered a conservative figure, as is also the light equivalent of 1 C. P. = 720 foot-pounds per hour. Logarithms of each number have been inserted, and the reciprocal of any equivalent will be found under its proper heading.

WORK.

H. P. in Foot-pounds. **One (1) horse-power** = 33,000 (log. 4.518514) foot-pounds per minute = 550 (log. 2.740363) per second = 1,980,000 (log. 6.296665) foot-pounds per hour = .709 (log. $\bar{1}$.850646) B. T. U. per second = 42.53 (log. 1.628652) B. T. U. per minute = 2,552 (log. 3.406710) B. T. U. per hour = 2.219 (log. .346105) pounds of steam per hour at 80 pounds pressure (95 pounds absolute) = 2.2104 (log. .344441) pounds steam at 100 pounds pressure (115 pounds absolute) = .002933 (log. $\bar{3}$.467312) pounds carbon consumed per minute, or .176 (log. $\bar{1}$.24551) pounds carbon per hour = .1823 (log. $\bar{1}$.260787) pounds ordinary coal per hour = .1169 (log. $\bar{1}$.067815) pounds (= .0157 gallons log. $\bar{2}$.19590) ordinary petroleum per hour = .1276 pounds (log. $\bar{1}$.105781) good kerosene per hour = 3.925 (log. .593890) cubic feet ordinary house gas per hour.

B. T U. Steam.

Combustion.

Electricity and light. **One (1) horse-power** = 746 (log. 2.872739) Watts = 2,750 (log. 3.43933) candle power.

1 foot-pound per second in H. P. Electric light and B. T. U. and steam. **One foot-pound per second** = .001818 (log. $\bar{3}$.259594) horse-power = 1.3565 (log. .132343) Watts = 5 (log. .698970) candles = 4.64 (log. .666518) B. T. U. per hour = .004034 pounds (log. $\bar{3}$.605699) steam at 80 pounds pressure (95 pounds absolute) per hour = .004018 pounds (log. $\bar{3}$.604035) pounds steam at 100 pounds pressure (115 pounds absolute) per hour.

Ditto per minute. **One foot-pound per minute** = .0000303 (log. $\bar{5}$.481443) H. P. = .0226 (log. $\bar{2}$ 354108) Watts = .0833 (log. $\bar{2}$.920820) candles = .07733 (log. $\bar{1}$.888348) B. T. U. per hour = .00006723 pounds (log. $\bar{5}$.827548) steam at 80 pounds pressure (95 pounds absolute) per hour = .00006696 pounds (log. $\bar{5}$.825874) steam at 100 pounds pressure (115 pounds absolute) per hour.

Rotary delivery to get H. P. **In rotary delivery a force of 52.41** pounds (log. 1.719333) at an arm 1 foot long, making 100 revolutions per minute, gives one H. P. or a force of 100 pounds, acting on an arm 1 foot long, making 52 41 (log. 1.719333) revolutions per minute, gives 1 H. P. or a force of 100 pounds acting on an arm .5241 foot (log. 1.719333) (= 6¼ inches) making 100 revolutions per minute, gives 1 H. P. A force of 100 pounds acting on an arm 1 foot long, and making 100 revolutions per minute, gives 1.904 (log. .279665) H. P. Roughly we have 1 H. P. for 100 pounds pull on a belt running over a 1-foot pulley (1 foot diameter) making 100 revolutions per minute.

HEAT.

B. T. U. to work light and electricity. **One B. T. U.** (1 pound water raised 1° Fahr.) = 776 (log. 2.889862) foot-pounds. **One B. T. U. consumed per second** = 1.411 (log. .149500) horse-power = 1,052.6 (log. 3.022263) Watts = 3,880 (log. 3.588832) candle power. **One B. T. U. per minute** = .023515 (log. $\bar{2}$.371345) H. P. = 17.5433 (log. 1.244112) Watts = 64.66 (log. 1.810569) candles. **One B. T. U. per hour** = .000392 (log. $\bar{4}$.593200) H. P. = .2924 (log. $\bar{1}$.465977) Watts = 1.078 (log. .032619) candles.

Steam to work, light and electricity. **One pound of steam at 100 pounds pressure (115 absolute)** takes .07962 pounds (log. $\bar{2}$.901000) carbon, or .0824 (log. $\bar{2}$.915927) pounds ordinary good coal to make it from water at 62° Fahr., assuming no loss; it contains 1,154.5 (log. 3.062368) B. T. U. or 895,892 foot-pounds (log. 5.959315). If it were consumed in one hour it would represent—with no loss—14,931 (log. 4.174089) foot-pounds per minute = .45247 (log. $\bar{1}$.655565) H. P. = 337.6 (log. 2.528304) Watts = 1,244.5 (log. 3.094893) candles.

One pound of steam at 80 pounds pressure (95 absolute) takes .0793 (log. $\bar{2}$.899328) pounds carbon or .0821 (log. 2.914343) pounds ordinary good coal to make it from water at 62° Fahr., assuming no loss. It contains 1,150 (log. 3.060698) B. T. U. or 892,400 (log. 5.950551) foot-pounds. If it be consumed in 1 hour with no loss = 14,873 (log. 4.172400) foot-pounds per minute = .4507 (log. $\bar{1}$.65388) H. P. = 336.2 (log. 2.526625) Watts = 1239 (log. 3.09322) candles.

Combustion. **One pound of carbon consumed in 1 hour** = 14,500 (log. 4.161368) B. T. U. per hour = 11,252,000 (log. 7.051230) foot-pounds per hour = 5.683 (log. 754565) H. P. = 4,240 (log. 3.627304) Watts = 15,630 (log. 4.193895) candles = 15 (log. 1.176091) pounds water evaporated from and at 212° Fahr. = 12.56 (log. 1.099000) pounds steam made from water at 62° Fahr. to steam at 100 pounds pressure (115 pounds absolute) = 12.61 (log. 1.10067) pounds steam made from water at 62° Fahr. to steam at 80 pounds pressure (95 pounds absolute.)

Fuels to B. T. U.

Steam, work.

Light and electricity. **One pound ordinary kerosene consumed per hour** = 20,000 (log. 4.301030) B. T U. per hour = 15,520,000 (log. 7.190892) foot-pounds per hour = 7.838 (log. .894227) H. P. = 5,847 (log. 3.766966) Watts = 21,560 (log. 4.333557) candles = 20.7 (log. 1.316053) pounds water evaporated from and at 212° Fahr. = 17.325 (log. 1.238673) pounds water from 62° Fahr. to steam at 100 pounds pressure (115 pounds absolute) = 17.40 (log. 1.240050) pounds water at 62° Fahr. to steam at 80 pounds pressure (95 pounds absolute).

One cubic foot ordinary illuminating gas per hour = 650 (log. 2.812913) B. T. U. per hour = 504,400 (log. 5.702775) foot-pounds per hour = .25475 (log $\bar{1}$.406110) H. P. = 190 (log. 2.278849) Watts = 700 (log. 2.845440) candle power = .6729 pounds (log. 1.827936) water evaporated from and at 212° Fahr. = .563 (log. 1.750585) pounds water at 62° Fahr. to steam at 100 pounds pressure (115 pounds absolute).

LIGHT.

Light to work. B. T. U. Electricity, steam, and combustibles. **1 candle power** = .00036364 (log. $\bar{4}$.560672) H. P. = .2713 (log. $\bar{1}$.433411) Watts = 12 (log. 1.079181) foot-pounds per minute = 720 (log. 2.857332) foot-pounds per hour = .015464 (log. $\bar{2}$.189319) B. T. U. per minute = .92783 (log. 1.967470) B. T. U. per hour = .0008037 (log. $\bar{4}$.905102) pounds steam per hour at 100 pounds pressure (115 pounds absolute) = .0008068 (log. 4.906772) pounds steam at 80 pounds pressure (95 pounds absolute) = .000064 (log. $\bar{5}$.806102) pounds or .448 (log. 1.6512) grains carbon per hour = .0000661 (log. 5.820201) pounds ordinary coal per hour = .0000464 (log. 5.66644) pounds or .32475 (log. $\bar{1}$.511538) grains or .001531 (log. 3.184975) cubic inches or .000006628 (log. $\bar{6}$.821342) gallons ordinary kerosene per hour = .001427 (log. $\bar{3}$.154557) cubic feet ordinary gas per hour.

ELECTRICITY.

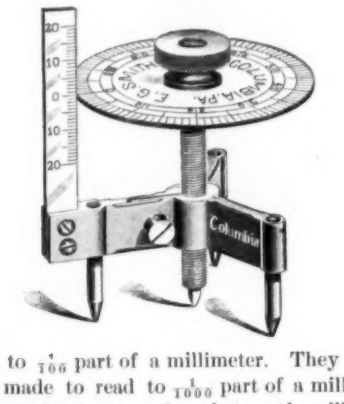
Electricity to work. B. T. U. Steam, light and combustibles. **1 Watt** = .0013405 (log. $\bar{3}$.127241) H. P. = .057 (log. $\bar{2}$.755913) B. T. U. per minute = 3.42 (log. .534064) B. T. U. per hour = 44.24 (log. 1.645775) foot-pounds per minute = 2,654.4 (log. 3.423966) foot-pounds per hour = 3.6863 (log. .566591) candle power = .000236 (log. $\bar{4}$.372696) pounds or 1.65 (log. .217794) grains carbon per hour = .000171 (log. $\bar{4}$.233034) pounds or 1.197 (log. .078132) grains good kerosene per hour = .005262 (log. $\bar{3}$.721151) cubic feet ordinary illuminating gas per hour.

It is announced by Secretary Hutton, of the American Society of Mechanical Engineers that the papers presented at the meetings of that society for 1895 will probably be devoted mainly to subjects connected with power, its generation, transmission and distribution. A general schedule has been sent to the members giving the divisions and sub-divisions of the subject which it is suggested be taken up, and these seem to cover sufficient ground to take up the time and absorb the paper-writing energies of the members of the society for the next five years at least.

A Spherometer.

We illustrate herewith an instrument made especially for measuring spherical surfaces.

The screw is threaded one thread to each millimeter, and the disk is divided into 100 parts, which allows the instrument being



read to $\frac{1}{100}$ part of a millimeter. They are also made to read to $\frac{1}{1000}$ part of a millimeter, by having two threads to each millimeter in the screw, and dividing the disk into 500 parts. The nut in the frame is provided with means to take up wear, and the legs, being screwed into the frame, can also be adjusted.

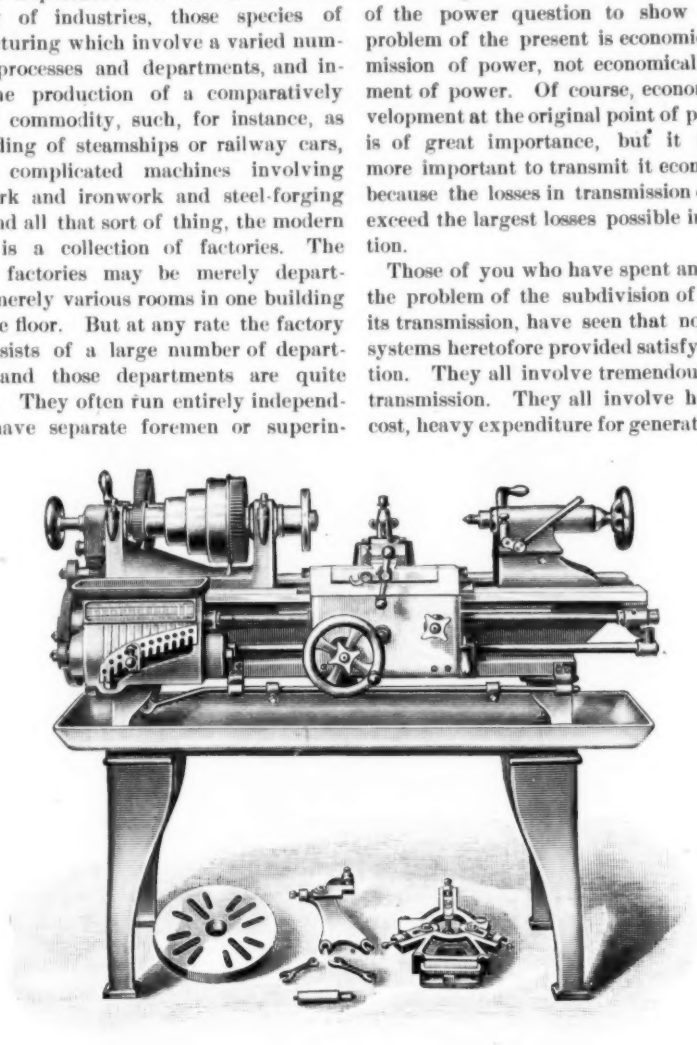
The maker also furnishes separate parts of the above instrument, such as graduated disks, and main screws with thumb nuts ready to use. These parts are very convenient for various experimental purposes, and are in mechanical and physical laboratories. It is made by E. G. Smith, Columbia, Pa.

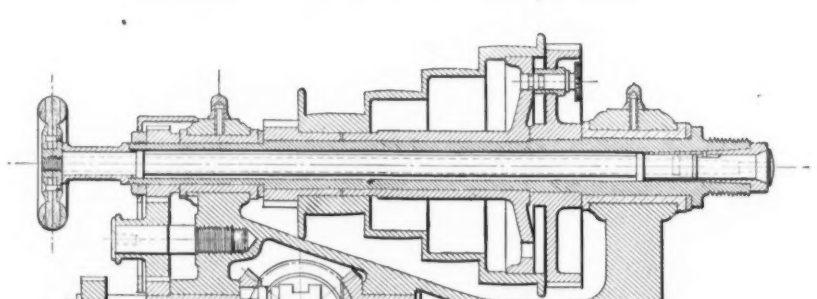
The Hendey-Norton Tool Maker's Lathe.

We present herewith engravings of a form of the Hendey-Norton lathe, which is especially adapted for tool makers' use, and for fine work generally. The lathe shown is 12 inches swing, 4-foot bed, mounted in an oil or chip pan.

The sectional view of the head stock shows the application of standard draw chucks, which are furnished with the lathe from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch, advancing by sixteenths, and, of course, any size can be used within the capacity of the spindle.

The lathe has the Norton device for changing gears for screw cutting and feeding, and has also the reversing motion and automatic stop motion for the carriage, both of which we have previously described. This lathe is made, with 4, 5, and 6-foot beds only, by the Hendey Machine Co., Torrington, Conn.





Head Stock of Hendey Norton Lathe

HENDEY-NORTON LATHE WITH DRAW CHUCK.

Gas and Oil Engines.—I.

As noted last week, the subject of gas and oil engines was discussed by engineers who met for that purpose, at the house of the A. S. M. E., Wednesday evening, April 10th. Mr. Emerson McMillan presided, and, after a few introductory remarks, to the effect that the gas engine had not had a fair chance in competition with other prime motors, introduced Mr. S. A. Reeve, who had been chosen to introduce the subject of the evening, and who said in part:

The status of the gas engine depends entirely upon the surrounding conditions. A plant exists merely because the sun shines, and the seed has been planted. Unless the surrounding conditions are favorable, the plant cannot exist, and the amount of its growth, and the character of its growth, depend entirely on the surrounding conditions. The gas engine follows this general law, in that its status to-day is what it has been forced to be, and what it has been allowed to be by the general commercial and engineering conditions of the world. Practically all other power that is in use is steam power. I do not lose sight of the tremendous amount of water power that is in use. But water power is restricted to certain localities, and the gas engine is not. It comes into competition only with those forms of power which are applicable to almost any locality or set of conditions, and, aside from gas power, steam power is almost the only other occupant of that class of prime movers.

The factory and the steam engine grew up together, and the idea that we have carried in our minds of a commercial manufacturing plant driven by any power, was a set of tools driven by a central motor through the medium of a line of shafting and a number of belts. That scheme of industrial works grew in size and importance until it had reached tremendous proportions, and in certain lines of industry it still survives, and will continue to survive in the future in still larger sizes, and on a still more important scale. But for the vast majority of industries, those species of manufacturing which involve a varied number of processes and departments, and involve the production of a comparatively complex commodity, such, for instance, as the building of steamships or railway cars, or the complicated machines involving woodwork and ironwork and steel-forging work, and all that sort of thing, the modern factory is a collection of factories. The various factories may be merely departments, merely various rooms in one building or on one floor. But at any rate the factory now consists of a large number of departments, and those departments are quite distinct. They often run entirely independently, have separate foremen or superintendents, run different hours, and have different classes of labor. In some labor is a small item, and power is larger. In others power is a small item, and labor is the principal feature. All these various conditions make it almost impossible for such an establishment to be driven by one central prime mover. In the first place, distance of transmission comes in and consequent losses. In the second place, come in varying conditions. Every engineer knows that no piece of apparatus can work well under varying conditions. We have therefore seen grow up the modern industrial works in which the power has to be transmitted quite a distance, and subdivided among a large number of different sorts of tools. This was first attempted by shafting and belting, or by rope drives. But it is evident that the losses by transmission are very great. Consequently we have seen other schemes tried. First came the subdivision of the steam engine itself into a large number of units, and we have only to look about us in our large factories to see steam-driven plants where the power is furnished from the central boiler plant to anywhere from ten or a dozen to 70 different engines scattered all over the works, sometimes 20 or more in one room. Sometimes the losses in steam transmission are, under average conditions, less than for shafting and belting. Of course, no cast-iron rule can be given for all conditions. But the subdivided steam plant has come in to stay. Of later years, superseding the subdivided steam plant, comes in, first, compressed air, and then electrical transmission and subdivision of power.

I have given this *résumé* of the changes of the power question to show that the problem of the present is economical transmission of power, not economical development of power. Of course, economical development at the original point of production is of great importance, but it is vastly more important to transmit it economically, because the losses in transmission can easily exceed the largest losses possible in production.

Those of you who have spent any time on the problem of the subdivision of power or its transmission, have seen that none of the systems heretofore provided satisfy the question. They all involve tremendous losses in transmission. They all involve heavy first cost, heavy expenditure for generating plant, transmission plant and redeveloping plant at the other end. For instance, in electrical transmission, if your total works need a thousand horse-power, besides your thousand horse-power of boilers, you must follow with a thousand horse-power steam engine, a thousand horse-power generator, your mains for carrying the electric power, and then on top of that a thousand horse-power of motors. That is, of course, losing sight of all small factors and percentages of loss. The present status of gas power in this country or any other, and also of its immediate promise for the future depends upon this statement of the problem in this part—that gas power offers the ideal solution for the subdivision and transmission of power, the mechanical difficulties being for the time lost sight of. In other words, let us suppose that a large industrial plant requiring, say, 1,000 horse-power, subdivided into, say, 50 different units which are utilized at various points, in different buildings, on different floors, at different speeds, for different hours during the day, under different conditions of varying and steady load—suppose that in such a plant as that, we install a 1,000 horse-power gas generator or its equivalent, and then lead from it or from the holder to a large number of gas engines, large central gas mains—it is evident that the first cost is away below that of any system, with the possible exception of the subdivided steam plant, where our boiler plant corresponds to our generating plant, our steam mains to our gas pipes, and our steam engines to our gas engines. But there is one big advantage which a gas plant has over a steam subdivided plant, in point of operation, and that is, that in the steam subdivided plant, no matter how large a proportion of the load be off, the central generating plant must be run, and the fixed charges of running cannot be altered. Steam must be kept up, the boilers must be kept hot, the stack, if there be one, must be kept hot, and the labor must be there to take care of the whole matter. I have myself tested one factory in which for a large proportion of each day the efficiency for the transmission of the power between the boiler plant and the work was 5 per cent., simply because they had to keep the whole plant going in order to move one small department. With the gas plant that entirely disappears. Your gas generator works for a certain number of hours a day, on whatever load or capacity is best suited to produce maximum economy, and as we all know, there is only one point in capacity in which any apparatus can work at minimum economy. During those certain number of hours a day the generator makes gas and stores it in the holder. The gas generating plant is entirely unconscious of the consumption of power, provided it be large enough to fulfill all demands. The consumers of power, the foremen of different departments, are as unconscious as is the generating plant of the consumption of power. They simply know that all they have to do is to turn on their gas and start their engine. They may run 24 hours in a day, while the gas generator runs eight, provided the total maximum production of the gas generator is large enough to cover the whole output of power. The comparison between such a gas plant and any plant relying upon transmission and subdivision of power, by compressed air or by electricity, or by any scheme wherein the power is first developed by the steam engine, and then converted into another form, and then converted back again—a comparison between the gas power plant and any such plant as that is really hardly possible from the economical standpoint. The operation of any such gas plant would be incomparably more economical than that of the compressed air or the electrical or the hydraulic system of transmission of power.

You will notice that I have entirely left out of the question the mechanical side of it, which I purposely wished to do. But for the merely commercial side there is an absolutely unlimited field for the development of power and its transmission and subdivision in industrial works by means of the gas generator and the gas engine.

In nearly all of our large textile mills in New England, and in a great many other forms of industry, the steam is used as much and sometimes more for heating purposes, and boiling and dyeing than it is for power. In fact, the big promoter of steam power in New England, where it has proved an indispensable auxiliary of water power, is the fact that the steam had to be had anyhow. That is true also of compressed-air plants. There are a great many factories where compressed air is indispensable for blowing, furnishing draft, cleaning and innumerable purposes to which it can be applied, and in a great many plants compressed air is used to transmit and subdivide power where no other system would be tolerated, simply because the compressed air has to be there anyway, and the compressed-air mains have got to be there and they might a great deal better use it for power. The same thing applies to electricity. Those factories relying on the electric current entirely for light may often bring the power question into secondary importance compared with light. If they have got to have their central engines

and generators and mains for the production and distribution of light, and if they need light more than power, then, of course, the electrical transmission of power is the thing without regard to the general arguments against it. But this same factor of the correlation of the system of transmission of power, and the system of transmission of other forms of energy needed in the works, applies also to gas. In fact, the gas producer has reached its present state of perfection largely owing to the fact that gas is the most economical form of fuel for a large number of industrial purposes—metallurgical, for glass works, and for a large number of sorts of cooking and heating and baking, where exact control of temperatures has to be had. In all those plants the power may again become secondary to other purposes in the factory, and in those plants where generators have already been installed for the purpose of supplying fuel gas, the gas engine follows as a natural sequence.

The reply to this side of the discussion—and you will remember that I am merely stating the discussion—the reply to this side of the discussion is that the mechanical difficulties have not yet been overcome; that the gas engine, after having had spent on it the best energy, or of the best energy, in the line of mechanical engineering which the world has been able to produce for some thirty years, is still more crude in a great many mechanical features than was the steam engine of a century ago. It is still very heavy. In nearly all of the devices only one impulse is received by the fly wheel for every two revolutions; in the case of the single-acting engines only one is received, so that the fly wheels are heavy. The regulation, as a rule, is accomplished by simply dropping out a certain proportion of the impulses, instead of varying their strength, and the necessity for the ignition of the charge in a minute fraction of a second has led until very recently to extreme uncertainty in the matter of ignition and also in the question of perfection of combustion. That last is not so marked a feature, because even with poor combustion the gas engine is an exceedingly economical prime mover, but the mechanical difficulties still stand in the way of the accession of the gas engine to the proper field in which it belongs; that is the universal factor for the production and transmission and subdivision of power in industrial works.

At the risk of being considered rather superficial in skimming over this subject, I will take one step into the future and say that while gas engines have hitherto been almost entirely run with illuminating gas, yet already there has been considerable done in the way of supplying gas engines with producer gas from special producers built for that purpose. There has also come upon the field—I will just mention it—the incandescent gas burner; that is, it has just begun to attract wide attention as being an established fact. These two coupled together—first, that the gas engine can be run much more economically upon producer gas, not illuminating gas, than it can upon illuminating gas, and second, that there is a means attained of producing illumination by a non-luminous gas, lead us to the surmise—perhaps I should not state it as a surmise, I will state it as a hypothesis which I hope to hear discussed—that the near future will see the distribution of energy—all energy—which is derived from coal in the form of a non-luminous, cheaply produced fuel gas, that this gas will be relied on entirely for power, for lighting, where gas lighting at all is permissible, and where it is not, where the electric light is needed, that electric light will be produced through the medium of gas engines, and that this same gas will be used for all sorts of fuel and heating purposes—domestic heating and cooking and industrial heating of all sorts.

I have tried to make as brief a statement as I could of the gas-engine problem as it appears to me to-day, not on the basis of the condition of the gas engine itself, but as a statement of its possibilities, the demands which are going to be made upon it in the near future and what the near future may bring forth in the way of a powerful auxiliary to aid in the adoption of the gas engine as the universal prime mover.

Mr. A. W. Burchard followed with a written account of a plant of gas engines, which account was referred to briefly last week, but at this writing is not ready for publication. At its conclusion, Professor Hutton read the following, communicated by Prof. Wm. S. Aldrich, of West Virginia University:

Some of the chief difficulties to the extended introduction of the gas engine have been gradually removed by the improvements in methods and apparatus for the manufacture of producer gas on a small, yet economical scale. In this as in other branches of engineering, the law of supply and demand operates to mutual advantage, and isolated gas-engine plants are rapidly coming to the front. On the other hand, for the distribution of power from a central plant to greater or less distances, gas offers peculiar advantages. There are practically no losses in distributing the gas in pipe lines, except leakages, which can affect the economy of the distribution. Losses of pressure and temperature changes do not in the least affect the economy of the gas engine at the end of the line. Therefore, the distribution of power by gas and its utilization in gas engines scattered over a widely extended area may come to be a rival of some of the other methods. And the facility of storage and use of gas for heating are additional advantages.

It seemed doubtful, for a long time, whether gas engines could be made and economically managed in large units; but the present use of the same up to 300 horse power and the contemplated manufacture of gas engines of 500 horse-power and upwards, leaves no room for serious doubting. But it is open to discussion whether there is the same inherent gain in economy in the use of large gas engines as in the case of steam engines. Of course, on the general principles of power production, large units are more economical per horse-power than small units. Nevertheless, there is scarcely an argument advanced for the use of large steam engines that can be similarly advanced in the case of gas engines.

In the matter of arrangement of gas-engine cylinders, there is undoubted preference manifested for the vertical type, and in pairs, with cranks at 180 degrees apart. Four-cylinder or quadruplex gas engines are being seriously considered, to gain an additional advantage along the same lines as the two-cylinder, or duplex type, namely, a greater number of explosions per revolution, and consequently an increased opportunity to control the supply and explosions according to the load.

As rotating or "rotary" gas engines have been suggested, it may be well to note some of the advantages arising from using the explosions of the gas in much the same manner as the Pelton wheel utilizes the steadily applied impact of the water. The losses due to connecting rod mechanisms are eliminated; the highest speed may be obtained and controlled—especially to be desired in direct connection to dynamos; multiple discharge jets (or explosion pockets) may be arranged, as in the Pelton wheel; the force of the explosion may be most directly utilized in a tangential manner; the internal friction will be reduced to a minimum; the best opportunities presented for regulating against the rapidly varying loads of electrical supply service; and, probably, a greatly increased economy in the use of gas.

In matter of speed regulation, gas engines have had an unenviable reputation, more due to the inherent difficulties of control than to any lack of inventive ability along this line. Always single-acting, frequently run at slow speeds, and sometimes with rapidly varying loads, it is not difficult to understand that during one or more strokes the supply of gas may be entirely omitted, and the unusually heavy fly wheel drawn upon to meet the periodic variations in the supply of energy.

Respecting the conditions of maximum economy in the use of gas, it has been found that there is a certain best load, for any given engine running at a given speed, at which load there is the least expenditure of gas per horse-power per hour. In this way it is possible to establish a very satisfactory basis for rating gas engines, that is, by their most economical performance. If gas engines could be tested and the curves of performance plotted, as in the case of turbines sent to the Holyoke testing flume, the whole gas-engine business would at once be placed on as satisfactory and substantial a basis as is now the case with turbines. The establishment of such a gas-engine testing plant is urgently needed. It would go far towards giving much needed additional encouragement to well-directed efforts in the development of the gas engine, as well as serve to forestall fruitless attempts in the same line.

(*Concluded next week.*)

LETTERS FROM PRACTICAL MEN.

Experience and Judgment are Necessary—A Slab Pile Indicator.

Editor American Machinist:

A good deal has been said of late on the subject of designing machinery, and I have noticed much valuable data relating to this subject, as it has appeared from time to time in your columns.

In referring to this subject it is not my intention to cross swords with any of these writers. Nor would I underestimate such helps, for the designer should thoroughly understand the nature of materials with which he has to deal, and preparation for such work, therefore, cannot be too complete. Is it not true, however, that a person, and especially a beginner, may make a complete failure as a designer, by placing too much dependence on helps from others? Evidently such a course often leads to the misapplication of rules which do not admit of a general application.

The work of designing implies, to my mind, origination, and he who never has an original idea is not apt to succeed when he attempts to appropriate the thoughts of others.

To emphasize this point, I cannot do better than to use a rather far-fetched illustration: The student of the various authors on whist will find when he comes to take a hand at this popular pastime, that he is often led into serious blunders by following certain rules, and he will probably blame the author from whom he gets his instruction, when he alone is at fault, for not having observed the many exceptions to established rules, or so mastered the subject as to be able to use his own judgment. To trace the simile a little further, we find the chief cause of trouble lies in the ever varying complexion of the cards held, and not until a player breaks away, in a measure, from trying to conform to the ideas of others, will he rise above the average in skill.

In the domain of constructive art, I think there is no less of complexity. Endless varieties of conditions confront the originator of each new machine or device.

Some of your contributors have already alluded to a few of the exceptional practices of designers, and have shown quite conclusively that *factors of safety* against strains, whether crushing, transverse or tensile, afford no criterion in designing certain parts of machines. I need not comment on the hurtful effect of even very slight deflection in many portions of accurately fitted machinery. Excepting machine tools, the steam engine suffers most, perhaps, from the yielding of parts which should remain immovable. Nor can we always stop where injurious springing ceases. A wrist pin, for example, may be of ample proportions to meet all ordinary strains, and yet not large enough to prevent excessive heating and consequent wear.

The factor of safety, then, against insufficient wearing surface for this small but important member in the steam engine, may, and indeed does, have a great variation, as practice clearly demonstrates.

Formulated data for securing the proper counterbalance in engine cranks have received much attention, and doubtless they are tolerably accurate. Yet I think there are questions involved in this problem which are not fully understood at all times.

It is no uncommon thing, when repairing machinery, to find a shaft journal worn badly on one side. The inference is strong that it has been out of balance, yet when running there may have been no evidence that such was the case. All who have had experience with high-speeded machinery, will have observed that a shaft which may run perfectly at its normal speed, say, of 1,000 revolutions, will sometimes vibrate violently at 500 per minute. This evidently shows that such a shaft is not in balance at any speed, and that above a certain limit of motion, the moment of inertia in the combined mass of the shaft and its belongings is such that there can be no response to the effects of the unequally distributed weight revolving about its axis. Doubtless this limited force is exerted continually, and produces the unequal wear on the journals referred to above.

It is fortunate, perhaps, that physical laws thus accommodate themselves to our formulæ and practice. Otherwise, I do not see what high-speed men could do to overcome the effects of constantly varying amounts of cushion in their engines, which would act as a disturber of balancing provisions, were it not for these laws over which the engineer has no control.

During the first year of my apprenticeship I secured a book that gave instruction on drawing, based on the works of M. Le Blanc and M. M. Armingand, and at the same time bought a set of instruments. A resolve was soon made to build a steam engine, a small one, of course. I distinctly remember that my drawings were nearly completed, and some patterns made, before it occurred to me that the slide valve had more to do than to admit steam to each end of the cylinder. It had to allow the steam to escape also. The discovery was startling, and caused some change in my drawings.

Many times since then I have seen the bad effects of incomplete designing. Some apparently trifling matter, perhaps, not well considered at the beginning, and when finally taken up, requiring changes which could illy be made.

The little engine was finished. It performed well. A junk dealer stole it, I think, and all I have to remind me of it is a silver cup, awarded me by an agricultural society.

While indulging in these personal memoirs, allow me to refer to a "slab-pile indicator," from which valuable information was secured. We did not know anything about the delicate little instrument those days that plays such queer tricks with its long and short connections; but went ahead with a sort of thumb rule, and designed a "real" engine, as the little people say. This was ten years later than the first experience above referred to. The engine was of the portable class, and of 20 horse-power. This, combined with a saw-mill, met with a fair demand, as was evidenced by the fact that sixty of these, including some other sizes, were shipped to points along one railroad of 60 miles in length. I had occasion to pass over this road frequently, and in doing so, observed that wherever one of these engines and mills was at work, a long rick of slabs, cut ready for burning, would be seen. While at other mills—some of our own make, but run by different engines—every slab would be burned, and in some instances other fuel had to be supplied.

If the comparison had been confined to two or three outfits, these observations might have been misleading, but so many mills operating in timber of comparatively uniform quality, gave the results more than ordinary significance.

Further investigation revealed a number of points of excellence possessed by the engine in question, to each of which a share of its good performance might be attributed, but none was more conspicuous than its slide valve proportions.

This conclusion has been confirmed by later revelations through the use of the

indicator, which, furthermore, proves that my good fortune in arriving at these proportions at the outset, was in a measure accidental.

However crude and unique the "slab pile indicator" test, it was, nevertheless, impressive, and carried conviction to those who might not comprehend the intricacies of a more scientifically conducted duty trial.

In conclusion, I would say to beginners to get all the information attainable, applicable to constructive problems, and then supplement the whole with a good measure of common sense. "QUIRK."

Steam Pipes.

Editor American Machinist:

Mr. Bullock's letter in your issue of March 21st, reminds me of the time when I took charge of the plant of a large saw and planing-mill, where the exhaust steam was used to prevent the mill from being rather colder than it was out of doors. The back-pressure valve was of a rather peculiar design, although a good one, for it was made when the chief engineer of the mill got out patterns for all such devices, had them cast at the foundry, and then they were finished up in the machine room of the mill, instead of buying them in the open market as we

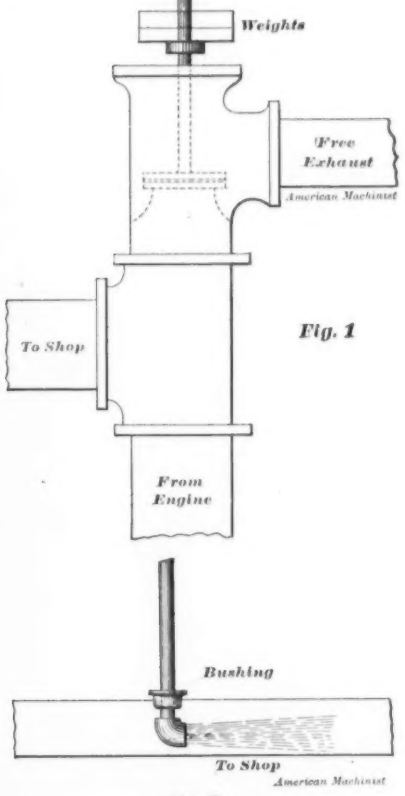


Fig. 1

Fig. 2

do now. It is shown in Fig. 1. It had no lever, for the weight acted directly on the valve, so that if you wanted to know how much back pressure you were carrying, the weight of the valve and stem, plus the weight put on them, divided by the square inches exposed to pressure, gave the desired information, provided the valve was lifted from its seat, as was the case usually, for but a part of the exhaust steam was used. As heat was sometimes needed in the mill before the engine was started up, provision was made for putting live steam into the coils, the connection being made in the same way as in Mr. Bullock's case. As the steam struck against the opposite side of the exhaust pipe, it inclined to come back towards the engine as much as it did to go around the mill, and as this was not always desirable, a valve was put in the exhaust pipe to prevent it. This valve was also of a home-made type, and I well remember my feelings when I opened it for the first time, and found that it required 31 turns of the wheel to accomplish this result. In order to avoid the necessity of this performance, a new connection was put in, as shown in Fig. 2. The bushing used was two sizes larger than the live steam pipe, and the elbow used was of the malleable iron kind, in order to be small enough to go into place. This illustrates how good results may be obtained in a straight line of pipe, no elbow being available, as in Mr. Bullock's case.

In one corner of one of the rooms in this mill was a place used as a filing room, and consequently it required more heat than in some of the other rooms. There were two large coils in this corner, but as they were never filled with steam, they were of but little value. An examination of the system showed that soon after leaving the engine, the pipe was reduced in size very rapidly, probably in order to save the cost of larger pipe, but after the reduction had been made, more branch pipes had been put in than the reduced mains could supply. One of these branches was so arranged that it appropriated more than its share, so a metal washer was put in a union in this pipe, the hole in it being much smaller than the pipe which it supplied. The result was that while this one got enough steam to fill it, none was wasted through it, and so the remainder went to supply the coils that were always cold before. As we did not think it necessary to explain how the trouble was remedied, and as no change in the piping was apparent, it was a source of wonder to the mill hands as to how the desired results were obtained.

W. H. WAKEMAN.

Steam Supply to Cylinder Jackets.

Editor American Machinist:

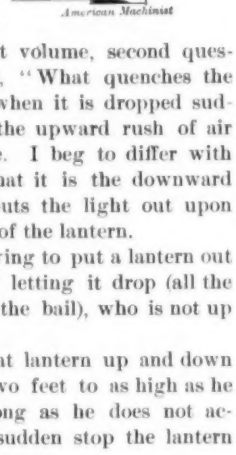
It is of interest to note a gradual change of opinion among steam-engine builders as to the method of supplying steam to cylinder jackets. Not so very many years ago, the man who would undertake to defend Watt's practice of passing the steam *through the jacket* on its way to the cylinder, was not often to be met with, while most of the writers on the steam engine at that period of its history were not slow to condemn the practice in most unmeasured terms. But now we find many of the leading builders adopting this system and with results which apparently justify them in reverting to the method adopted by the inventor of this much-debated steam engine appurtenance. There can be no gainsaying the fact that excellent results have been obtained from engines jacketed in this manner, so that—the strictures of the thermodynamist notwithstanding—the practice is likely to be more widely adopted in the near future. Quite recently, one of the most prominent engine-building concerns in England announced its conversion to the belief that only in this way were the best results to be obtained from jacket action, provided always that precautions are taken and ample provision made for clearing the jackets of water. The latter is, of course, a most important requirement in any system of jacketing, but it is not difficult to see that in the system just now considered failure to effectually clear the jacket of water would more prejudicially affect the steam economy than would be the case if the steam to the jacket was directly supplied. It is unquestionably true that the scouring action of a large volume of steam in rapid movement over the outside surface of the cylinder lines, considerably enhances the efficiency of heat transference to the body of working steam, inasmuch as this surface is effectually cleared of moisture as soon as the latter is formed. Further, with this rapid circulation of steam through the jacket, lodgments of air are impossible, and as these are, in many instances, the prime cause of inefficient jacket action, this advantage alone is of no mean importance.

But assuming that the plan of first passing the steam through the jacket is adopted, is it necessary that the *whole* of the working steam be passed around the cylinder, and would not an equally good effect be obtained if only one third (or less, perhaps) was diverted *via* the jacket? If so, would there not be less risk of the moisture in the jacket being swept into the cylinder before it can be drained away? M. E.

Leaky By Pass.

Editor American Machinist:

I recently changed a throttle valve on a large fire pump, attached to a large manufacturing establishment, principally because of a troublesome by pass. The steam pipe is four inches in diameter, and the throttle valve is fourteen feet below the top of the steam drum, where the pump pipe is attached, and considerable water would collect above the valve, thus disabling the pump for instant use, as the water had first to be drained on starting up. A machinist was instructed to put in a by pass that the pipe might be kept clear of water, and the inclosed sketch will explain the attachment. But trouble has been given by constant leaking, as the by pass enters the bowl of the valve at a considerable angle, and all attempts to stop the leak were unsuccessful until a $\frac{1}{16}$-inch hole was drilled in the valve at a point where the arrow is shown as passing through. This drains out all condensation, and allows enough steam to pass to keep the pump warm and ready for instant use.



In the Question and Answer columns of the AMERICAN MACHINIST of March 14th, present volume, second question under No. 98, "What quenches the flame in a lantern when it is dropped suddenly?" You say the upward rush of air blows out the flame. I beg to differ with you by claiming that it is the downward rush of air that puts the light out upon a very sudden stop of the lantern.

Observe a man trying to put a lantern out by holding up and letting it drop (all the time holding it by the bail), who is not up to the trick.

He will pump that lantern up and down all the way from two feet to as high as he can reach, and so long as he does not accomplish the very sudden stop the lantern continues to burn.

Take an ordinary domestic lamp, and blow into the bottom of the chimney until your head aches, and the light still burns. Then observe the slight puff required to put the light out when directed into the top of the chimney.

You know the Irishman contradicted the verdict of a coroner's jury upon the dead body of his brother by claiming that it was not the fall that hurt him in the least, but stopping so suddenly was what put his light out. S. A. SMITH.

Henderson, Ky.

Is There a Standard for Rivets?

Editor American Machinist:

Is there a formula or table giving lengths and diameters of thousand or pound rivets?

I find that the productions of no two makers agree on this style of rivet.

I purchase a 4-pound rivet made by one concern, and find it exactly the same as a 3½-pound rivet made by another party.

If there is a formula or standard I fail to find it.

Any information you can give in your Question and Answer columns will oblige.

Cleveland, Ohio. H. Y. E.

Engine Settings.

Editor American Machinist:

In your issue of March 21st Mr. Williams, in discussing engine settings, speaks of using thin cement mortar, flowed in to fill the space between foundation and engine. This is, as he says, a somewhat unsatisfactory method on most work; and a much better plan, which is largely used and which, with reasonable care, will give uniformly good results, is this: After the engine or other machine is leveled up on wedges, mix a stiff mortar about as stiff as putty, of equal parts good cement and building sand. It is well to test the cement by mixing a small portion and leaving it over night to see if it hardens properly; in a few hours it will, if of good quality, become quite hard and firm. The sand and cement should be very thoroughly mixed while dry, and only a small amount wetted at a time. After being worked for a minute or two it should be used as quickly as possible. The plan is to drive this stiff mortar into place with a mallet and a piece of wood three or four inches wide, and thin enough to go between the foundation and the base of engine. If the cement is only to support a narrow flange around the edge of the machine, some means would be provided to prevent the mortar being driven through. Generally it is easy to wedge in some pieces of board so as to make a backing to drive the mortar in against. Well rammed in this manner, and stiff enough not to settle by its own weight, the cement sets very quickly, becomes hard as rock, and without any trouble from shrinkage, as is often experienced when it is used thin enough to flow.

For setting machine tools, particularly long lathes and planers, this method is about the only one that can be used for best results. Such tools should not be set on separate pieces or butments, unless there is solid rock to build upon, for it is impossible to prevent unequal settling. The foundation ought to be deep, the deeper the better, but need not be wider than the base of machine. Before starting the mason work the bottom of the excavation should be compacted as much as possible by thorough and heavy ramming. The best material for the foundation is concrete, one part of good cement to from three to six of sand; testing as before mentioned to make sure the mixture will set hard. Some cements will carry more sand than others, and the quality of sand varies greatly. As much coarse gravel and broken stone is worked into this mortar as it will stand, and the whole is dumped into the pit and rammed until it settles down level, and a blow at one place will disturb the surface all around it. If water settles on top there is too much being used, for although the cement will harden under water, it will set harder and shrink less if much hard ramming and very little water be employed. It is best to mix in small quantities, not over two or three wheelbarrow loads at a time, and to commence at one end of the pit and carry through a layer four or five inches thick, repeating until the excavation is filled. Should the earth not come to the floor line a rough board curbing can be made to give the foundation proper shape. A foundation made in this way becomes practically one large rock, and is much better adapted to carry an accurate tool than brick or stone work as usually constructed.

It is impossible to do a good job in setting a long lathe or planer without the use of a sensitive level. One in which a change of angle of $\frac{1}{1000}$ inch to the foot will move the bubble $\frac{1}{16}$ inch to ¼ inch, costs from $10 to $15, and is not found in every tool chest, or tool room either, but is absolutely indispensable if long machine tools are to be properly set. With such a level, used with a straight-edge long enough to reach across the machine, long lathe or planer beds may be leveled up straight and out of wind, even if they have been sprung in handling, or were not planed perfectly true originally. It is surprising to see how easily such a machine can be sprung, and how short a section of bed, unsupported, will show deflection by its own weight. The end of a heavy 60-inch lathe bed, projecting 36 inches over the blocking, will deflect by its weight an amount which can be detected by such a level as described. To wedge up long tools properly is a job calling for much care. Iron plates about the size of a man's hand should be placed from 12 to 18 inches apart all along under the edges of the machine. The wedges are best made of about ¾ inch square iron tapered to a thin edge, and 8 inches to 10 inches long. When the machine is finally wedged up straight, true, and out of wind, there will probably be anything but an equal bearing on the wedges. Some of them will be loose, or taken out altogether, and in other places it will have been found necessary, as the leveling proceeded, to concentrate several plates and wedges to hold up some point which persists in remaining low when the wedges are equally loaded. After the wedging has held the machine level and true for at least two or three hours without perceptible settling, the cement should be rammed in as quickly as possible.

E. J. ARMSTRONG.

Weight and Mass.

Editor American Machinist:

This question of weight and mass appears to get weightier (or more massive) every day. I have been thinking about it, as I did without the bicycle discussion, that by and by someone would say just what I had had in mind, in a much more lucid way than I could express it. However, on re-reading Professor Wood's article, it seems to be pretty much all there, after all.

The quantity of matter in a body, that is, its *mass*, is dependent upon two things only, the volume of the body and its density. A bale of cotton may be three feet thick when it goes into the hydraulic press and only ten inches thick when it comes out, but its *mass* is the same. What it has lost in volume has been compensated for by increase in density; the matter is all there yet. Right here is where "Anti-Know-All" errs, regarding his cubic foot of iron and cubic foot of wood. The latter has *not* "as great a mass," though it may displace as much air; however, even this latter statement is doubtful. Even a cursory examination will show the difference in density, and a lens of only moderate power would go far toward helping "Anti-Know All" to answer his own question.

As Professor Wood said: "Mass is the most absolute thing with which we have to deal," but *weight* is not, because it varies as the observer's position on the earth varies. The great trouble is that weight has been the *only* measure of mass that we "practical men" have been accustomed to, and we have been the worse "tangled" because our steelyards or platform scale have helped to carry out the deception. We might go from Quito to Uppernavik with our steelyards and lump of lead or cubic foot of iron, weighing it every mile, and, if it didn't wear out, never detect any difference in the weight, for the earth would increase its pull on the counterpoise in just the proportion that it increased on the lead or iron. But if we measure the earth's attraction for that constant *mass* by the distortion it produces in a helical spring, then we shall see where we have been tricked, shall see how weight may vary though mass remain constant, and shall see *why* we must multiply our constant factor mass by the variable factor "g" to obtain the variable product, weight.

Notice how carefully Professor Wood has made this distinction. He did not say that our constant mass, weighed by a steelyard, in a deep mine or far above the earth would weigh only half a pound, while it weighed a pound on the surface. The steelyard beam would show the same reading in all three places.

To sum up, then, our mass is an unvarying unit, so long as volume and density remain unchanged. The weight will vary as the earth's attraction for that mass varies. Stated as a proportion the mass bears the same relation to unity that weight does to the earth's attraction, or $M : 1 :: W : g$; whence $W = Mg$.

Even now we must not accept this equation as a mathematical dictum, without our explanatory "grain of salt." But as weight is our most convenient measure of mass this much we can rely on: If, at the same place, one body *weighs* twice as much as another, we know it contains twice as much matter—has twice the mass. Again, the world over, if we multiply a body's mass by the value expressing the earth's attraction at that point, we shall have the body's weight, or the reverse is equally true. Thus much we can swear by.

It doesn't seem to me that "Bell Crank" has "tangled up" the subject as badly as he wishes us to think. The amount of a quantity to be measured may be a constant, yet the expression of its measurement be as varied as "Bell Crank" has made this of mass. For example, we will assume the hight of the ceiling in his office to be twice his own hight. By that standard alone it is 2. In ordinary units it is perhaps 12 feet; but 4 yards, or 3.66 — meters, or 144 inches, express it equally well. The hight is all there yet; it hasn't increased or diminished as our measure has shrunk or stretched. The thing measured is no more elusive than our "absolute thing," mass. Weight expressed in pounds, distance expressed in feet, and time expressed in seconds, are our recognized English standards in the measurement of force, and so long as they are adhered to the acceleration produced by gravity, expressed in feet per second, will always allow us to "tie to" our mass as a constant.

In reply to "Bell Crank's" first question, suppose we alter somewhat the conditions without altering the principle involved. Let us suppose that over a frictionless pulley, by a weightless and perfectly flexible cord, are hung two half-pound weights. They are in balance, and to move them, we move one pound practically isolated from the influence of gravity, like his one-pound sled on frictionless ice. These are, of course, the ideal conditions of Atwood's device. Now this whole pound, falling freely, would move over 16.08 feet in the first second. To move the two half pounds, under the above conditions, one foot in a second, would require $\frac{1}{16.08}$ or practically $\frac{1}{16}$ as much force as to move the pound the 16.08 feet per second. In the case of the freely falling pound, the moving force is the weight of the pound. In the case of the balanced weights, the force required (acting for one second) would be practically one ounce, as we are accustomed to measure force.

If we return to the one-pound sled, and adapt the wording of Mr. Porter's article, "the one ounce, being $\frac{1}{16}$ of the force that is exerted on the sled by gravity, would, in any given time, move it through $\frac{1}{16}$ the distance, and impart to it $\frac{1}{16}$ the velocity that gravity would." That is, acting for one second, it would move the sled one foot and impart to it a velocity which during the next second would—unaided—carry it over a space of 2 feet. A force twice as great (approximately 2 ounces) would move the sled through 2 feet the first second, and impart, by the end of that time, a velocity of 4 feet per second. Will "Bell Crank" feel safe now in applying Professor Wood's formula for centrifugal force to the solution of his second problem?

Now, Mr. Editor, if I have helped "Bell Crank" to "tangle up" this thing any tighter, I will rest contented to let some older head unsnarl it, in some subsequent paper.

Novice.

The Proper Method of Projection.

Editor American Machinist:

Noticing with some surprise the difference in opinions expressed by your correspondents in the matter of placing views in mechanical drawings, I am led to believe that a statement of practice should be made by men who are actually in the shop and at work making and using drawings, and who know what goes through the departments without trouble, with no mistakes, and no requests for information from the drawing room.

I require the use of the "third angle," and place the plan over the elevation, the right-hand elevation on the right-hand side, and so on. I do not agree with Mr. Halsey, in your issue of April 4th, that this question will never be settled. The practice is now nearly uniform, and it seems to me that no chief draftsman should permit the use of the two systems of projection by the men under his charge, and I am certain that no chief who has many men under his charge could tolerate the confusion and errors which seem to me certain to arise if both systems are used together. It also seems strange to me that any man of judgment should adopt the idea of looking through a piece of cast or wrought metal to see what the other side is like.

Drawings should first of all be wholly beyond question, and it is absurd to say that the choice of the individual draftsman should in any case be allowed to interfere with unvarying uniformity of method, because without unvarying uniformity question is inevitable.

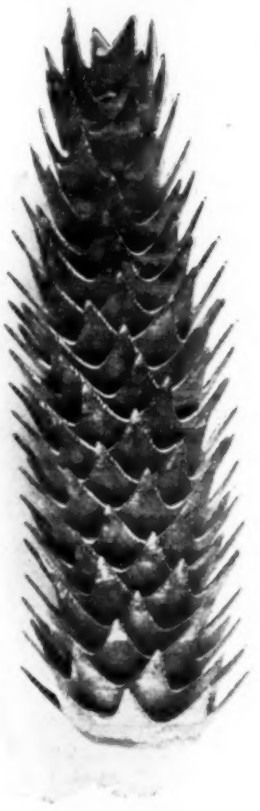
I think a general expression of the practice of men in charge of considerable numbers of draftsmen, would, if printed in your columns, soon settle this seemingly groundless dispute.

D. H. Macdonald,
Chief Draftsman,
Providence Steam Engine Co.

Another Peculiar Chip.

Editor American Machinist:

I read in your paper a few days ago [page 187] an article in reference to a peculiar chip, which you illustrated. Here is one which I would call a "pine burr." We made a number of them several years ago. Samples of which created some comment in the office here, no one being able to guess what they came off of. Thinking there might be one still about, I looked for them, but failing to find any, I asked my foreman



of department in which they were made, if he would make me one to send you, and you will see the result.

I also send you sample, which I think perhaps comes very near to what you described; they came off of 1¼-inch round machine steel, turning it down in one cut to 1 inch diameter.

M. L. Orum.

Philadelphia, Pa.

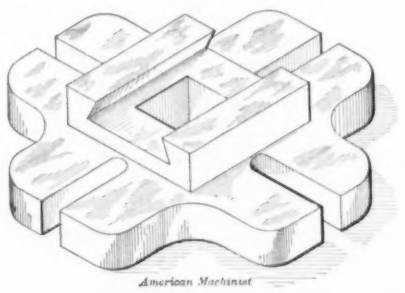
[The chip which we illustrate (full size) is certainly a very peculiar one, and the chip itself (whatever the engraving may be) is a beautiful one. Our guess is that it was turned from a square bar of steel, and if so, it shows a remarkably smooth and uniform cutting action for such a job.—Ed.]

Dies and Die-making.

Editor American Machinist:

I was greatly interested in the article on "Die-making," in your issue of March 14th, and heartily concur in the ideas advanced by "P. D." I think, as he says, that a little thought and skill, and not so much cast-steel, will make a better die, and one that will produce more work.

I will frankly admit I do not like his style of die shoe, and I send a sketch of one that,



while it has all the good points of his, also has a few of its own.

First, it is made of a steel casting, and if "P. D." will try one of that metal he will never want any more cast-iron ones.

It will take a 2-inch, 3-inch, or 4-inch die, and can be set either way in the press.

No drilling for the bolts is necessary, as the four slots take care of that part.

To hold the dies in the shoe, I prefer keys instead of set screws, but I think that is a matter of habit more than anything else. The corners are cut out so it can be used in a small as well as a large press. I have three sizes of these that take all sizes from a 2-inch to a 12-inch die.

In the cutting of sheet metal, I am of the same mind as "P. D.," and am a firm believer in the use of compound dies, and I have yet to find a flat blank that cannot be finished at one stroke of the press.

A. P. Press.

Hydrokineter.

Editor American Machinist:

In your issue of March 21st, J. G. G., S. Lake Linden, Mich., asks what is a hydrokmeter?

He probably has reference to the hydrokineter, an apparatus used by large steamships for circulating the water in their boilers while raising steam. I have only seen a few of them, and do not remember much about them, except that they are built by G. & J. Weir, of Glasgow. All the ships that I have had any connection with use a donkey pump for circulating, drawing the water from a valve in bottom of boiler, and discharging into the same boiler through the feed checks, which answers the same purpose.

With boilers 16 feet 6 inches diameter, 20 feet long, of the Scotch type, one would scarcely credit the difference in temperature between bottom of boiler and water level unless water is circulated by some such means.

It is not necessary to publish this unless you see fit, as I only write it for the information of one who apparently has run across something that puzzles him a bit, as I often do.

Geo. M. Taylor.

Vancouver, B. C.

Engine Tests of Hirn and Hallauer.

Editor American Machinist:

In the article on "Initial Increase of Entropy," etc., by Charles M. Jones, the experiments by Hirn and Hallauer are referred to as having been made on a "toy engine."

Whatever may be thought of the remainder of the article, a statement of this sort should not go unchallenged.

As a matter of fact, the Hirn engine, tested by Hallauer with saturated and with superheated steam, developed some 140 horse-power at 30 revolutions per minute. Certain compound stationary engines, tested by Hirn, developed over 300 horse-power at 25 revolutions, and some marine engines, for which he reported tests with the heat analysis, developed some 6,000 horse power at 73 revolutions per minute.

Those who have spent most time and thought in making and studying steam-engine tests are most ready to learn from any source, but may we not expect those who teach to know and tell the exact truth about experiments quoted?

Boston, Mass. C. H. Peabody.

The new vessel of the American line, the "St. Louis," which is now being finished at Cramps, is scheduled to sail from New York, June 5th, on her maiden voyage. Work upon the vessel is being rushed in order to complete her in time, and about 1,000 men are at work on board the vessel besides those on shore. The starboard engines were turned under steam on the 17th and worked very smoothly, giving especially steady turning at very slow speeds.

The Columbian Iron Works, Baltimore, have been awarded the contract for all three of sea-going torpedo boats for the U. S. Navy.

The boats will be of about 138 tons displacement, and will have a speed of about 24 knots. The vessels, exclusive of armament, will cost $97,500 apiece. The Columbian Works were the lowest bidders.

The Cotton Manufacturers' Association, of Fall River, voted April 16th to advance wages to the schedule in force previous to August 20, 1894, and at this writing it is expected that the advance will be general throughout the cotton-mills of the State.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
CHARLES W. BIGLOW, Treas. and Sec'y.

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Subscriptions received in Paris, France, by E. TERQUEM, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. WILLIAMS, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, APRIL 25, 1895.

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Bolts with Threads Finer than Standard.

A valued correspondent sends us a communication in which he relates his experience with bolts made with twice as many threads per inch as would be called for by the U. S. standard, and with heads and nuts considerably smaller. These bolts were made under the direction of Major W. R. King, U. S. Engineer, and some of them when tested by pulling showed something over 18⅛ per cent. greater strength than similar bolts cut with standard threads.

"The importance of the result," says Colonel King, "is evident from the fact that a net increase of about 20 per cent. in the statical strength of bolts, and 150 per cent. in their resistance to sudden strains, can be made by simply using finer threads, and at least 40 per cent. of iron in the head and nut can be saved by making them that much lighter."

It is, we think, pretty well understood by those who have given the subject any attention, that bolts made of steel, iron or brass are stronger if made with threads considerably finer than called for by the U. S. standard. This was recognized by Mr. Wm. Sellers, when he read the original paper before the Franklin Institute in 1864, and this paper, which will be found in the *Journal* for May of that year, shows that a very careful investigation had been made by him, and the proportions of pitch to diameter settled upon only after a complete investigation of the practice of leading shops both here and abroad; the conclusion, and a fair one, evidently, being that pitches which had thus been the result of natural selection and survival of the fittest, so to speak, were likely to be those best adapted to serve the varied purposes to which bolts of various materials were put.

Upon the presentation of this paper a committee consisting of nine members, all practical men, were appointed to investigate and report upon the matter, and in the *Journal of the Franklin Institute* for January, 1865, their report will be found. In it the following paragraph occurs:

"As in every instance the threads now in use are stronger than their bolts, it became a question whether a finer scale would not be an advantage. It is possible that if the use of the screw thread was confined to wrought-iron or brass, such a conclusion might have been reached, but as cast-iron enters so largely into all engineering work, it was believed finer threads than those in general use might not be found an improvement, particularly when it was considered that so far as vertical hight of the thread and strength of bolt are concerned, the adoption of a flat top and bottom thread was equivalent to decreasing the pitch of a sharp thread 25 per cent., or, what is the same thing, increasing the number of threads per inch 33 per cent. If finer threads were adopted they would require also greater exactitude than at present exists in machinery of construction to avoid the liability of overriding, and the wearing surface would be diminished; moreover, we are of the opinion that the average practice of the mechanical world would probably be found better adapted to the general want than any proportions founded upon theory alone."

The matter was investigated also for the U. S. Navy before its adoption by the department, and in May, 1868, a report was made upon the matter by a board appointed for the purpose, in which report there is a full discussion of the subject. On September 10, 1886, *Engineering*, of London, published an article in which it was stated in effect that this proposed standard had never been generally adopted here and had been virtually abandoned. This led to a letter of inquiry on the subject from the Society of German Engineers, Berlin, and before replying to this the secretary of the institute, Dr. Wm. H. Wahl, inquired into the matter and published in the *Journal* for April, 1887, replies from eight large railroad systems and from other users of bolts showing its very general adoption here. The *Journal* for March, 1888, contains a long and able paper by Mr. John L. Gill, showing very clearly the advantages to be gained in strength by increasing the number of threads per inch.

Bolts with threads finer than standard are often used where it is necessary to economize space or material, but it is apparent from what has been said that the standard pitches probably suit the requirements of general practice—varying conditions and various materials—better than any other pitches, either finer or coarser; and we feel quite certain that fine pitched screws are used in many places where standard threads would be better. On the spindles of lathes, for instance, where in most cases standard threads would leave ample strength of spindle, would wear much better, and make chucks and face plates easier to put on and remove.

The Gas Engine and the Steam Engine Joined.

Referring to the discussion of the gas-engine question, a prominent engineer remarked in conversation that he failed to see why the gas engine and the steam engine should not be compounded, so to speak. He put the case something in this manner: In the gas engine one of the problems is to keep the cylinder reasonably cool, and in the steam engine to keep the cylinder hot. Now, suppose we have a gas engine running and jacket its cylinder with water, which is then used for boiler-feed water, thus saving the heat which is now thrown away. Then take the exhaust from the gas engine through the jacket of the steam cylinder, and, if necessary, as it probably would be, add a heating chamber for the steam to pass through just before reaching the cylinder, so that more heating surface could be employed. Two such engines adapted to each other would probably mean a relatively small gas engine and a steam engine large enough to carry all the load in case the gas engine refused to work for any reason, and, arranged in this way, each would supplement the other so far as the proper distribution of heat is concerned. The proposition is a novel one, and there is a chance to do some thinking over it. Possibly someone may be so situated as to make it easy to try the plan and let us know the results.

A Novel Application of Mathematics.

In *Indian Engineering*, a Calcutta journal, there has appeared a number of articles under the caption "Inkstands and Other Gear," in which the design (?) of the useful writing accessory has been spun out on geometrical, dynamical, and various other principles, the sixth article having just come to hand, and more being promised.

The enervating influence of the climate of India, combined as it usually is with the various "dopes" considered necessary as dispellers of ennui, is well known, and all just men are inclined to make due allowance, but it would seem that developing differential equations for the proper building of writing fluid holders was getting too close to the dead line that divides mental exercise from incipient paresis, and the Indian service would be justified in ordering its employe to take a run in the Swat region, where bracing camp life, enlivened by forays against the now obstreperous natives might soon calm the mental irritation of the mathematician and fit him to undertake and enjoy investigations of a healthy and useful sort.

A Massachusetts legislative committee, which went South early in March to investigate the question of the development of cotton manufacturing there and its probable effect upon the industry in Massachusetts, has made a report which is not at all discouraging to Massachusetts people, but rather the reverse. The report makes it rather plain, that while the South has some certain advantages over New England, the advantage is not all with the South. It is declared that not all the Southern mills are making money, and that some of them which are not in operation can be purchased for less money than the machinery cost. While four Massachusetts corporations have sought the privilege of manufacturing cotton outside the State, it is declared that none of these contemplates a removal of its Massachusetts plant. It is evident there has been some jumping at conclusions in regard to so-called removals of cotton factories to the South.

Literary Notes.

INDICATOR DIAGRAMS, AND ENGINE AND BOILER TESTING. By Charles Day, Whitworth Scholar.

This work, which is issued by the Technical Publishing Co. (Limited), No. 2 Amen Corner, London, E. C., explains the construction of several makes of indicator, and gives instructions for attachment, etc.

Examples of good, bad, and indifferent cards are included, with methods of testing engines and boilers, tables of piston constants for facilitating the computations of power, etc. Price, 4s. 6d.

BELT DRIVING. By George Halliday, Whitworth Scholar.

This book contains notes on belt driving, used by the author in his lectures to the advanced mechanical and electrical students of the Technical College, Finsbury. It gives descriptions of different kinds of belts, and treats on power transmitted by belts, length of belts and coned pulleys, stretching of belts, V pulleys, arms of pulleys, discussion relating to methods of use of the belt, rope gearing, tables, and rules for finding the pitch of spur gearing.

The author presents these subjects in a very instructive manner, and those who are familiar with algebraic expressions will have no difficulty in mastering this branch of engineering. We regret to notice that the book shows evidence of careless proofreading, there are several typographical errors which may be very annoying to the young student. For instance, on page 11 the author refers to Fig. 23, which shows a belt passed over two pulleys of unequal diameters; from the center of the smaller pulley a line $e f$ perpendicular to the belt is drawn, and from the foot of this perpendicular a line $f h$ is drawn parallel to the center line $d c$ of pulleys and terminating in a line drawn from the center of the larger pulley perpendicular to line $d c$; we are then informed that $f h$ is equal to the distance between the centers of the pulleys, which evidently is a mistake. In connection with the solution of example 1 on page 12, table 3 is referred to, but we cannot see that this table has anything to do with the example. On page 13, a letter k is used in the solution of the same example without specifying the significance of this letter; we presume that this is a typographical error, and the letter K given on page 10 is meant. There are other errors which might be mentioned. Although none of them are very serious they indicate carelessness, and this lessens confidence in the work, and their correction would greatly enhance its value.

It is published by Spon & Chamberlain, 12 Cortlandt street, New York. Price not given.

A correspondent residing in France informs us that Mr. Gustav Richards, of Paris, will shortly publish in two volumes a very complete treatise on machine tools, which will include engravings and description of the leading products of practically all the leading tool builders of the world, and will range from the lightest and finest tools used in watch manufacture, up to the heaviest tools built by American and European builders.

We have received the first number of a new paper entitled "The Mexican Exposition." It is devoted to the interests of the exhibition of industries and fine arts, to be inaugurated in the city of Mexico, April 2, 1896, and contains a number of illustrations of the proposed buildings, and portraits of the leading men of the enterprise. The paper is published at San Francisco, Cal., by the American Mexican Exhibition Co.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(164) C. W., ——, writes: Please give me the address of the parties who publish Loetzer's "Hand-book for Machinists." *A.*—It is published by the author, C. E. Loetzer, 211 William street, Williamsport, Pa.

(165) J. J. A., Cannon Falls, Minn., asks: What kind of glue is best to use on emery polishing wheels to keep the emery on? *A.*—We believe that any good glue is satisfactory for this purpose, if the work is properly done.

(166) J. D. B., Houston, Texas, writes: Some time ago I read in your columns the notices of two books, one treating on the setting up, management, and repairs of the Corliss engine; and the other treating on the management of steam pumps. The information I most particularly desire is how to set the Corliss engine valves, also the piping and repairs of steam pumps. Please give me the names of the books and where published. *A.*—"Corliss Engine, and Management of the Corliss Engine," edited by E. P. Watson, published by Spon & Chamberlain, 12 Cortlandt street, New York; "Pumping Machinery," a practical handbook relating to the construction and management of steam and power pumping machines, can be obtained from the author, William H. Barr, 3223 Powelton avenue, Philadelphia, Pa. We expect to publish in our columns at a very early date, an article treating on the setting of the Corliss engine valves.

(167) W. W., Buda, Ill., asks: Will you inform me of the ingredients of a bath that will harden pieces of tool steel that must be as hard as possible without being brittle? I have tried Mushet's steel, but it does not seem to stand the work. The cutters are for sharpening the disks on pulverizing harrows, and sometimes these are very hard. *A.*—It is a mistaken notion to assume that the performance of such work is a mere question of hardness in the steel that is to do the cutting, because one steel may be as hard as another and yet be entirely unfitted for work which the other can do easily. It is, aside from the question of hardening, a question of quality; that is, steel which is to do a particularly difficult job of work must be of the best quality as well as properly tempered, and we think that when the quality is adapted to the work, the ordinary process of hardening, that is, heating to the proper temperature and quenching in water, is sufficient, though salt added to the water is often beneficial.

(168) C. R., Berwick, Maine, writes: Kindly inform me if copper and steel can be melted together and rolled into sheets about $\frac{1}{16}$ inch thick and still have the same spring quality that would be had by uniting two pieces of copper and steel of the same size. *A.*—Copper and steel have been melted together, but we have no reliable data as to the results at hand. It is certain, however, that when the steel contains more than 0.9 per cent. of copper, the steel will be rendered redshort; in fact, the chief effect of copper is to render steel redshort and destroy its welding power. Better results have been obtained with a smaller percentage of copper; there are Bessemer T-rails made with 0.51 to 0.66 per cent. of copper, and they are said to be so non-redshort that, in spite of their thin flanges and the exceptionally low temperature at which they are finished, only from 1.25 to 2.5 per cent. of them are sufficiently cracked to be classed as second quality. We believe that you will not obtain the desired results by melting copper and steel together.

(169) W. E. B., Detroit, Mich., writes: Kindly inform me in regard to the following: In what way can a rubber stamp be used for printing titles on drawings made on the glossy side of imperial tracing cloth? There may be a special ink and a special way of preparing the cloth. I have never used any ink but Higgins', and use pipe clay for rubbing the surface of the cloth before drawing on it. *A.*—The cloth does not require any further preparation than you have adopted. In place of pipe clay you may use powdered chalk, or, better yet, a piece of chamois for rubbing the surface of the cloth. In place of the ink use an ink or color pad such as are furnished with the rubber stamps, and then use the stamp in the ordinary way. 2. Can steel castings be softened for working up and then hardened through and through, also, can drop forgings be treated in the same way? *A.*—Steel castings are generally annealed before they leave the foundry, and if these are not soft enough for working, it is doubtful whether you can improve them. The degree of hardness to which steel castings and steel drop forgings can be brought will depend on the proportion of carbon in the steel. Forgings which are comparatively thin, say, $\frac{1}{4}$ inch thick, can practically be hardened through and through.

(170) C. V. A., Baltimore, Md., asks: What will be the quantity of water delivered in a minute through a pipe $1\frac{1}{4}$ inches diameter, and 40 feet long, under a pressure of 40 pounds per square inch? There are four ordinary elbows in the length of this pipe. Please give formula. *A.*—First find the velocity by the following formula:

$$v = \sqrt{\frac{2\,g\,h}{1 + m + f\,\frac{l}{d} + n}}$$

in which v = velocity in feet per second; g = acceleration of gravity = 32.2 feet per second; h = head in feet due to the pressure; m = loss of head at entrance = .5; f = friction factor = .02; l = length of pipe in feet; d = diameter of pipe in feet; and n = loss of head due to each elbow = 2. The head due to a pressure of 40 pounds is $2.304 \times 40 = 92.16$ feet; substituting the above values for the letters in the formula, we have

$$v = \sqrt{\frac{2 \times 32.2 \times 92.16}{1 + .5 + .02 \times \frac{40}{.125} + 2 \times 4}}$$

= 18 feet per second. Now, multiplying this velocity by the area of the pipe in square feet, we obtain the number of cubic feet discharged per second. The cross-sectional area of this pipe is .0122 foot, hence the discharge per second will be $18 \times .0122 = .2196$ cubic foot, and per minute $.2196 \times 60 = 13.176$ cubic feet. In the above computations we assumed that the pipe is clean and smooth inside.

(171) G. P. G., Findlay, Ohio, writes: I am building a small engine with cylinder $2\frac{1}{2}$ inches diameter and 3 inches stroke, steam ports, $1 \times \frac{3}{16}$ inch, exhaust port, $1 \times \frac{3}{8}$ inch. Kindly give me the dimensions of the following parts: Thickness of piston, width and thickness of piston packing rings, thickness of cylinder walls, length, width and travel of valve, width of bridges, length and width of crosshead, size of crank pin and crosshead pin, diameter of steam and exhaust pipes, diameter of valve stem. *A.*—Solid piston $\frac{1}{2}$ inch deep with 2 packing rings made of steel, $\frac{1}{8}$ inch square; cylinder walls, $\frac{5}{16}$ inch thick; flanges, $\frac{1}{4}$ inch thick; length of valve, $1\frac{1}{2}$ inches; width, $1\frac{1}{2}$ inches; travel of valve, $\frac{3}{4}$ inch; bridges, $\frac{1}{4}$ inch thick; crosshead, $1\frac{1}{4}$ inches long, $\frac{3}{8}$ inch wide; overhung crank pin, $\frac{1}{2}$ inch diameter; if it is a center crank pin its diameter should be equal to that of the shaft; steam pipe, $\frac{3}{8}$ inch diameter; exhaust pipe, $\frac{1}{2}$ inch diameter, and valve stem $\frac{3}{16}$ inch diameter. 2. I intend to build a porcupine boiler made up of one piece of 6-inch pipe, and a number of pieces of 1-inch pipe screwed into the 6-inch pipe; engine and boiler are to be placed in a boat. Please give me the length of the 6-inch pipe, and length and number of pieces of the 1-inch pipe; size of safety valve and grate surface; also, how far from the top of the 6-inch pipe shall the 1-inch pipes be placed so as to allow sufficient steam room? *A.*—The 6-inch pipe should be about 35 inches long; use about 60 pieces of 1-inch pipe 7 inches long; these pieces may extend to within 6 inches from the top of the 6-inch piece. Diameter of grate surface, 20 inches, safety valve, 1 inch diameter.

(172) J. L., Hamilton, Canada, writes: I have used crude coal oil for removing scale from boilers, but the result was not very satisfactory. I then tried washing soda, and after that I used boiled potatoes strained, but none of these solutions kept the boiler as clean as it should be. I am now using the following compound: Extract of oak bark, Irish moss, washing soda and extract of tobacco stems. After being properly prepared, I put a gallon of it in the boiler on a Saturday at noon (we shut down at one o'clock on Saturdays) and let the compound remain in the boiler until Monday, when I found all the dirt and scale on the bottom of the boiler. What I wish to know is, is there anything in this compound injurious to the boiler, or is there anything that I could add to it, that would make it more effective? *A.*—We should hesitate to use this compound. The oak bark contains tannic acid, which is liable to injure the plates. Where tannic acid is found to act well, perhaps the best mode of applying it is to suspend in the boiler a log of oak wood with the bark on, from which the acid is gradually extracted. In all cases where tannic acid is used, its effects on the plates should be carefully watched. The tannic acid decomposes the lime salts, and forms tannate of lime, which is insoluble at first, and forms a scum which should be removed by surface blowing off. The remaining constituents should also be blown off frequently, as their concentration is liable to tell severely on the iron, unless the acids be neutralized by sufficient alkaline substances, purposely introduced; the soda may have this effect; however, the compound should be used with caution, if not abandoned altogether. Crude petroleum has been used in boilers, and with judicious application has been successful in removing and preventing scale. The chief objection to crude petroleum is that it is too heavy, and when it mixes with the mud, will form a thick paste which may become so dense that water from the hose will not dislodge it. In place of crude petroleum use kerosene oil, it is light, and will not form a paste as above referred to. In many instances, kerosene has given entire satisfaction.

(173) R. M., Philadelphia, Pa., writes: Please give a method for setting the Meyer valve gear. *A.*—In the first place, set the main valve correctly in the same manner as an ordinary slide valve is set. We shall assume that this has been done, and confine our attention to the cut-off valves. Set the cut-off eccentric directly opposite the crank, place the cut-off valves in the center of their respective threads, as near as can be done by ordinary measurements, great accuracy is not necessary, and make complete connections between eccentric and cut-off valves; also, connections between main valve and eccentric. Now set the crank in position at which, under ordinary conditions, the steam is to be cut off, then set the corresponding cut-off valve to cut off at this point; this is accomplished by turning the valve stem so as to spread the valves or draw them together, as the case may require. Now turn the crank in the direction in which the engine is to run until the piston is at the same part of the stroke as at the other end of the cylinder when the cut-off took place. If now the corresponding valve is not in a position to cut off, then lengthen or shorten the distance between the valves and eccentric by one-half the difference that this valve is out of its correct position. Lastly, turn the valve stem so as to set the valves for the correct points of cut-off. Verify the result by turning the shaft through two or three revolutions; a little readjustment may be necessary. The above method of setting is for valves whose outer edges close the ports. When the inner edges close the ports, the cut-off eccentric must be set in direct line with the crank. These positions of the cut-off eccentrics are correct for marine, hoisting, and other engines which are to turn in both directions, since the motion of the cut-off valves is then correct for both forward and backward rotations. In stationary engines the angular location of the cut-off eccentric is not a matter requiring great exactness. In these engines the cut-off eccentric is not usually placed so far in advance of the main eccentric; a common location is 45 degrees in advance, the position depending much on individual judgment and preference.

(174) F. A. B., Westfield, Mass., writes: Kindly give me a rule for computing the thickness of metal in a tank 20 inches inside diameter, made of mild steel; it is to withstand a pressure of 1,000 pounds per square inch. *A.*—For computing the thickness of metal in this tank, we may use the ordinary rule for computing the thickness of boiler plates. Multiply the pressure per square inch by the inner radius in inches of the tank, and divide the product by the safe working stress per square inch of metal; the result will be the thickness of the metal. This rule may be expressed in symbols as follows:

$$\frac{P \times R}{S} = T; \qquad (1)$$

in which P = pressure in pounds per square inch, R = inner radius of tank, S = safe working pressure in pounds per square inch of metal, and T = thickness of metal in inches. For mild steel, double-riveted butt joints, we may take for S a value of 9,100 pounds, hence we have,

$$\frac{1{,}000 \times 10}{9{,}100} = 1.1 \text{ inches},$$

very nearly, for the thickness of steel in the tank. For these high pressures, some engineers prefer to use the following formula:

$$\frac{P \times R}{S - P} = T; \qquad (2)$$

in which the letters denote the same quantities as before. According to this formula, we have,

$$\frac{1{,}000 \times 10}{9{,}100 - 1{,}000} = 1.23 \text{ inches}$$

for the thickness of steel. It should be remembered that the thicknesses as found above are for the cylindrical shell only. 2. Please give rule for computing the stress per square inch of metal in a given tank. *A.*—If the tank is cylindrical, we have from formula (1):

$$\frac{T \times S}{R} = P; \qquad (3)$$

in which the letters denote the same quantities as before. If, for instance, the thickness of the steel is 1.1 inches, and $R = 10$ inches, we then have:

$$\frac{1.1 \times 9{,}100}{10} = 1{,}001 \text{ pounds} \qquad (4)$$

per square inch of metal in the cylindrical shell. The pressure per square inch which the heads can sustain will depend on the form of the heads. For flat heads, we may adopt the following formula:

$$\frac{3 \times S \times T^2}{2 \times R^2} = P. \qquad (5)$$

If the tensile strength of the steel is 60,000 pounds per square inch, and if we adopt a factor of safety of 5, then the working stress S per square inch will be 12,000 pounds, and if the thickness of the heads is one inch, then according to formula (5) we have:

$$\frac{3 \times 12{,}000 \times 1^2}{2 \times 10^2} = 180$$

pounds per square inch for the pressure which this head can resist. But it must resist 1,000 pounds per square inch, hence we have $1{,}000 - 180 = 820$ pounds pressure per square inch of head which must be resisted by the braces. The area of the 20-inch head is 314.16 square inches, and therefore the pressure which the braces must resist is $314.16 \times 820 = 257{,}611$ pounds.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 312.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patents, H. F. Parker, Att'y, 26 Cort'ndt St., N.Y.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

70 Uses of Compressed Air mailed free. Clayton Air Compressor Works, 28 Cortlandt street, N. Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Gardenier's "Ready Help for Locomotive Engineers." Price by mail, $1.00.
Edward Meeks, publisher, Philadelphia.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Wanted—Agents. Mach., tool & patternmakers, and draftsmen, to buy "Hand-book of Practical Mechanics." An arithmetic of mech's in the simplest form. Only book of its kind. Send $1 for cloth, $1.25 leather cover. C. H. Saunders, P. O. Box 963, Hartford, Conn.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Modern Furnace vs. Cupola Practice—II.

By Thos. D. West.

CHARGING, DESCENT AND REDUCTION OF STOCK.

During twenty four hours there is charged into a furnace, the size shown in Fig. 3, about 280 tons of ore, 190 tons of coke, and 60 tons of limestone; a total of 530 tons of material passing through the furnace every day, producing daily about 165 tons of iron.

In charging a furnace, two gangs of men are employed, one on top, the other on the ground floor, loading the buggies and wheeling them to the elevator, which ascends a hight of 70 feet in about 20 seconds. There being two cages to the elevator, an empty is returned as the loaded buggy ascends. The buggies hold about 800 pounds of ore, and of coke 450 pounds. The men

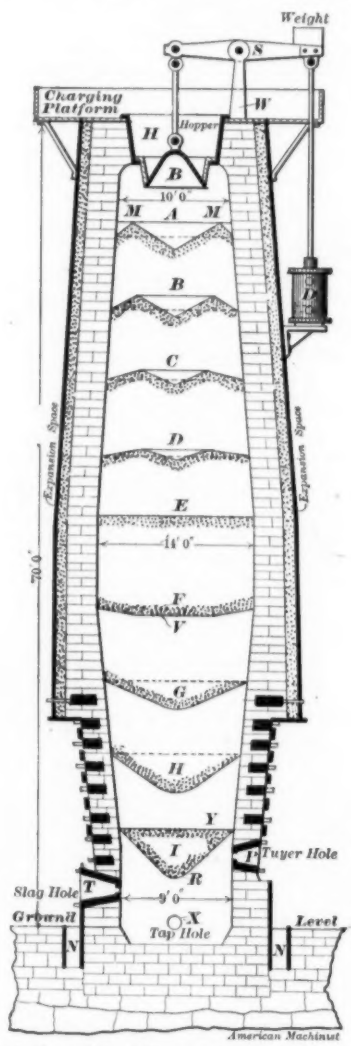
charging the furnace are called "top fillers," and those loading the buggies, "bottom fillers." The work is thoroughly systematized, each man knowing his part. The top fillers hold a somewhat hazardous position, as it is no uncommon affair for men to be "gased" by the fumes escaping at the bell and hopper of a furnace. A number of men have lost their lives by being made insensible before they were aware of any real danger from the effects of the gas which first shows its influence by causing headaches. Men becoming used to these, often get careless in being thus warned of danger, and the last thing they can know is a sense of sinking to the floor from which they may never rise alive. Some furnaces suspend a sheet-iron stack about 10 feet high over the top of the bell on the charging platform for creating a draught to lessen the volume of gas.

In charging the stock, the coke, limestone and ore are generally charged in the order mentioned, and dropped independently of each other in the hopper *H*, Fig. 3. After the completion of each charge, the bell *B* is then lowered as indicated, and the material falls down in the furnace shown, about as illustrated at the mound *M M*. After delivery of the charge, the bell returns to its position, ready to receive the next supply of stock. There are several ways for operating the bell, but the method used with the furnace shown, is that of moving the beam *S* up and down by means of a cylinder *D*, which can be operated by steam or the blast pressure. The bell must be hung true, if one side should swing lower than the other, when the stock is admitted to the furnace, it would be charged uneven, and have a tendency to assist scaffolding and cause evil results, similar to uneven charging of stock into a cupola.

All material that is charged into a furnace passes off either as a liquid or a gas. The gas chiefly escapes at the top, passing through the "down comer" to the ovens to heat the air which is driven through the pipes in them on its passage as blast to the furnace. The liquid elements pass off as iron or slag, both formed at a point ranging from a level with the tuyeres to a height of 4 feet above them, which latter is generally called the "melting zone," the hottest part of a furnace. As the coke, limestone and ore settle in their descent, any moisture that may exist in the stock is first driven out. The stock then becomes rapidly heated and in its passage downward to what is called the "reduction zone," the largest diameter portion of a furnace, it becomes plastic, and as it proceeds is melted and falls in a fluid state to the bottom. The non-metallic or earth matter, in separating from the ore, is absorbed by the lime, and being lighter than iron, floats on its surface, and is tapped off as slag through the hole *T*, Fig. 3, while the iron is delivered at the tap hole *X*.

According to the nature of the ore charged, certain pressure and temperature of the blast and percentage of limestone are necessary to attain the best economy in fuel and output, and bring down the latter as a good No. 1 iron. If the blast pressure is too high, it forces a volume of air into the furnace too large to be absorbed by the fuel. As the blast entering the tuyeres is of a much lower temperature than that of the furnace, the excess of air or its oxygen which cannot be absorbed by the fuel or its carbon, only robs the furnace of heat to raise the excess of air to a higher temperature than that at which it entered the furnace, and results in cooling the furnace down, and giving a product called "cold iron," or a low grade of iron.

If ore is not properly reduced a percentage of its iron can pass off with the slag, on account of not being thoroughly extracted from the non-metallic matter of the furnace; and what iron is obtained will be lower in silicon and higher in sulphur, for the reason, that the heat of the furnace being insufficient to reduce the silica in the ore and fuel to the degree it is reduced when the furnace is working hot. The silica in the ore and fuel is what causes the silicon in the iron, and the hotter the furnace can be made, the more silicon will the pig metal contain, all else being the same. As silica is a very refractory material, hard to melt, it can be readily perceived why a cold furnace would generally give lower silicon in the iron produced. Carbon in iron is obtained from the fuel in a furnace, and the same can be said of sulphur. Iron in the ore, also the limestone used to flux it, absorb sulphur. Which of these two elements in the process of reduction will absorb the greater percentage of sulphur from the fuel depends upon the degree of heat each possesses. Lime has a great affinity for sulphur, and if it is reduced thin and hot it will rob the iron of its share of sulphur, but if the furnace is working cold, so as not to properly flux the limestone, then the iron will absorb and retain more sulphur than the lime, and hence the higher



Action of Stock Descending a Furnace

Fig. 3.

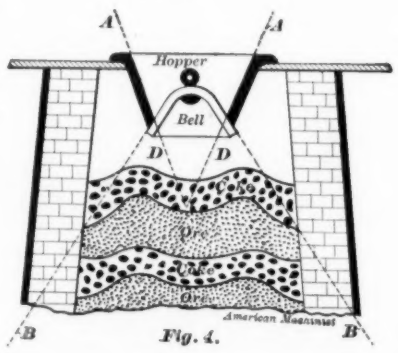


Fig. 4.

sulphur found in iron coming from a cold working furnace. Then again, if a furnace is hot, the lime can absorb more silicon as well as sulphur by having the silicon pass off as silica in the slag, so that there is a happy medium, and in a manner, the results obtained can, to a large degree, be the same in a cold or a hot furnace, as far as the percentage of silicon is concerned. This shows the difference which may exist in the practice of two furnacemen who may yet obtain a similar result. The way high silicon and low sulphur iron, or No. 1 pig-iron, is generally obtained is by having a hot furnace well, but not excessively, fluxed with lime. To make high silicon and high sulphur iron, as is often obtained, and which can be a No. 1 or 2, but more generally a No. 2, is achieved by having a hot furnace poorly fluxed with lime.

Hard and "white" iron, which means low silicon and low sulphur, is generally caused by a cold furnace, as this favors the union of sulphur with iron, and retards the iron absorbing silica from the fuel. A cold furnace gives a bad, thick slag the same as a cold cupola retards good fluxing or slagging out. A good working furnace sends the silicon into the pig, and the sulphur into the slag; a poor working furnace sends the sulphur into the pig, and the silicon into the slag.

A few points in sulphur have greater influence in controlling the grade of iron than the same number of any other chemical property of an iron. This I have proven by recent experiments in testing the influence of silicon *vs.* sulphur, in effecting the grade produced in the re-melting of cast-iron, and the effect is similar when making iron.

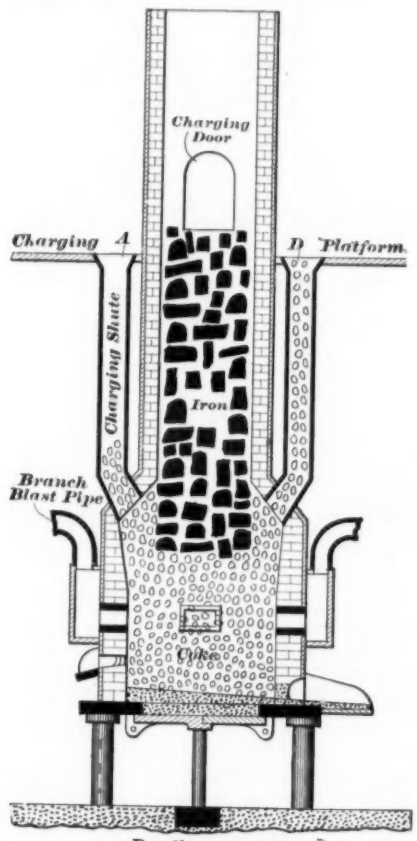


Fig. 5.

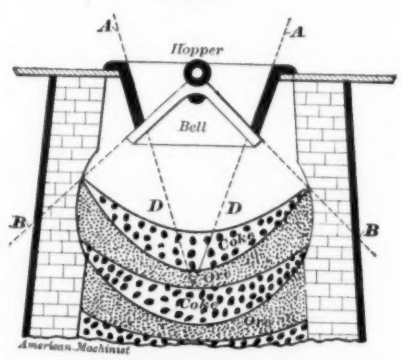


Fig. 6.

There is much wild speculation among managers and molders as to what is the proper amount of blast to use, many being of the opinion that they cannot have too much, if they can get the lining to stand it. We have but to study the workings of furnace practice in this line to show us that there is such a thing as having too little or too much blast in a cupola, as well as in furnace practice, and that we can regulate results in the product when melting and mixing metals by an intelligent knowledge of the effect degrees in blast pressure and fluxing can have.

Most every furnaceman has his own ideas as to the lines of a furnace to achieve best results with special ores. There are over 500 blast furnaces in the United States today, and nearly all of them differ in their lines, etc., more or less. Since the publication of Mr. James Gayley's valuable paper on "The Development of Blast Furnaces," read at the New York meeting of the American Institute of Mining Engineers, in October, 1890, the lines now generally adopted in this country for coke furnaces are more in accordance with those outlined in the Edgar Thomson furnace "F," in which the hearth is about half the diameter of the largest part of the bosh, and the throat or top of the stack about ⅔ of the bosh's largest diameter, in a hight of about 80 feet.

An experienced furnace builder, with whom I discussed the matter, thought that for the use of a large percentage of the Messaba ore, which is a very soft ore, and would be taken by the molder to be a coarse grade of molding sand rather than a substance containing about 64 per cent. of iron, that a straight lining with a different arrangement than the present hopper and bell for charging would prove more effective in preventing scaffolding and slips than is achieved by such lines as exhibited in Fig. 3. Experience with straight lines in a cupola should be of some assistance in deciding this question, and whether a change in mode of charging would be of any value.

In reasoning out the action of stock in passing down through a furnace, it would seem desirable to attain, if possible, an occasional shifting movement so as to retard the formation of any solid union of the stock. This is best achieved with a taper stack, as the stock in passing downward should assume an action something similar to that illustrated in the various levels, *A*, *B*, *C*, *D*, *E* and *F*, seen in Fig. 3. When stock is dropped by a bell, such as in the size of furnace shown, it generally, if all is working well, distributes it in a form somewhat like that in the mounds *M M*, seen at the level *A*, which is called the stock line, and is generally 10 feet below the level of a bell. The stock in settling down to fill the increasing diameter of a tapering stack must have a spreading out or leveling action taking place, or, in other words, the outside would descend faster than the inside stock. It seems reasonable that the tendency of the stock in settling would be for the angles to be constantly leveling themselves something after the idea illustrated at the various stratas *B*, *C*, *D* and *E*, until it had reached the commencement of the bosh at *F*, when a reaction would take place, and the stock in descending would be retarded by the walls of decreasing diameter in such a manner as to cause the center portion to travel faster than the sides, until at the last strata *I*, the stock would have traveled ahead of the side stock, as shown at *I*.

Before this point is reached, however, the stock is fluid, as by the time any plastic stock has reached the level at *Y*, the iron has generally been extracted from the ore, and what passes the point *Y* is generally as fuel to replenish the "bed," molten metal, or a refuse which will be carried off as slag.

The total length of the lines at the different levels, *B*, *C*, *D*, and *E*, are the same, and the theory of action of stock may be wrong, but seems to have a basis in reason. In cupola practice we have an advantage over the furnace in being able to observe the action of the stock until it has reached the "melting point." In observing stock settle at the last charge in a straight cupola, when all is working well, little or no change is noticed in the position of the material, and this is generally so true that the founder knows that whatever way stock is delivered into a cupola, it will be found at the "melting point." For this reason we often have experience with bunged-up cupolas or iron dumped at bottom down, which could not be melted; owing to fuel or iron not having been charged evenly. Often stock reaches the melting point with fuel most all on one side and iron on the other, through carelessness in charging in that manner

The difference noticed in the workings of straight and tapering cupolas, or those smaller at the charging door than at the level of the tuyeres, or just above them, would strongly lead a founder to say that the actions above outlined for a furnace were not far from the action in a cupola. Iron in working down a tapering cupola is at short intervals changing its lateral position, causing an agitation of the stock, making it more difficult to wedge or hang itself up, than if passing down a straight cupola. Only in the case of excessively bad working, or a very ragged, worn-out lining in a small cupola, is there any fair chance for stock hanging in a tapering cupola. Were we to reverse the taper so as to have

a cupola from its charging door down to the tuyeres like the bosh portion of a furnace, then we would be greatly troubled with stock hanging up. In very large cupolas the diameter is generally the smallest at the tuyeres in order to save fuel, and have blast reach the center with more force. From a few feet above the tuyeres large cupolas generally have parallel sides to the charging door. This plan is an approach to the principle found in the bosh and stack of a furnace, and to a degree works the same as attaining results. Furnacemen claim that scaffolding is generally done in the bosh portion of a furnace. The founder's experience with cupolas brought in at the tuyeres would sustain the common sense of such a claim, also that it was not desirable to make a bosh of too great an angle.

The main study of the furnaceman to-day is the question of obtaining regularity and avoiding slips, and many are of the opinion that such ends are to be achieved as much by the method adopted for charging the material as by the shape of the furnace lines.

Where the bell and hopper are used for charging stock, the angle and diameter of each, as compared to the diameter of the furnace at its throat or stock line, have all to do with the form and position which stock assumes when dropped into it. The angle of the hopper influences that of the bell in determining the distribution and position of coarse and fine material, also the formation of the irregularities in mounds which a charge may assume, after being dropped by a bell into a furnace. It would not be a bad idea for furnacemen to test the actions of such angles by means of inclines formed of boards or sheet metal with the actual stock intended for use before deciding on the angle and diameter of hoppers and bells. By such a test a furnaceman could then learn very closely the manner in which the stock would be delivered, an element which now seems to be largely one of guess-work.

Some years ago Professor Richards, of Boston, made a model of a furnace having a glass front, so that the action of stock in descending a furnace might be observed. The material which was selected to represent ore, lime and coke was taken out at the bottom and filled in at the top. Much was claimed for the experiments in showing the true action of stock in descending a furnace, but after the Professor had brought his experiments to the notice of English furnacemen, it was found that Sir Lowthian Bell had previously experimented with a similar device; but the opinion seems to prevail that while such a model was very instructive, still through the lack of conditions as regards heat, etc., not being present, it was at its best not of the value expected in demonstrating the true condition which actually existed with stock in descending a furnace in general practice.

There are three elements affecting the descent of stock and preventing slips, which is the great evil all aim to overcome. The first of these is the lines of a furnace. The second, the manner in which stock is delivered or charged, and the third, the quality or nature of the ore and fuel used. A few years ago experts said that the Messaba ore could not be smelted in a furnace, owing to its being so fine and loamy. But the large percentage of iron which they contain, their low phosphorus (making a good iron for Bessemer pig) and little sulphur, three very desirable elements, which, combined with low cost, caused furnacemen to try it and persevere in its use, until to-day it is a large percentage of the ores charged into many furnaces. Nevertheless, furnacemen are finding much trouble from slips and wastage of ore in the form of fine dust being carried out with the gases through the "down comers." There is much study being given in hopes to devise methods to overcome the difficulties encountered.

Most every furnaceman has some new idea which he thinks will prove a success if given a trial. As these cannot be often tested without an outlay of many thousands of dollars, about as far as many ideas can get in achieving their end, is by lines on paper. A late plan being now adopted by some furnaces in order to work Messaba ores, is that of decreasing the diameter of the hopper and bell. A few which have lately taken out their old bells and replaced them with smaller, are said to report a very commendable improvement in preventing slips when using Messaba ore. The action of the small bells causes the fine material to occupy the center portion and the coarse the outer portion of a furnace, something after the plan seen in Fig. 4. The reverse action caused by the use of a large bell is illustrated in Fig. 6. This method of arranging the fuel more to the outside and the ore to the center, brings to mind a similar plan which has within a year been tested in remelting iron in a cupola, and which is a very radical departure from any past practice, and was invented and patented by Mr. W. H. Bradley, Mingo Junction, Ohio. Mr. Bradley's plan is to keep the iron and fuel separate, the iron being in a solid column in the center, with the fuel encircling it at the bottom for a few feet in hight, and the fuel bed under the iron the same as in present practice. In order to keep up the "bed" in all past practice it has been done by charging the fuel with the iron in alternate layers. Instead of replenishing the "bed" by carrying the fuel down between layers of iron, Mr. Bradley's plan is to charge the fuel into shutes encircling the outside of a cupola, which carry the fuel down to replenish the bed as seen at *A* and *D*, Fig. 5. The opening of the shutes is level with the charging platform, as seen, and to regulate their delivery of the fuel to the "bed" and the escape of gases, dampers or valves are used at the lower portion of the shute where it enters the cupola. The iron is charged through the charging door as in ordinary practice. The cut, Fig. 5, should at a glance afford a knowledge of the general principle involved. Mr. Bradley has not yet, to my knowledge, any new cupola in use, but he has at the steel works of which he is superintendent, an old cupola which was remodeled so that the principle involved in his method could be tested. Mr. Bradley claims that a comparison of the records of the old and new method shows quite a saving in the fuel, destruction of lining, oxidation of metal, and in obtaining a good slag. This new plan is such a radical departure from all past practice that I would not dare to venture an opinion as to its success. There is one thing certain, if it achieves what Mr. Bradley claims for it there is a very strong probability of this principle displacing much of our present practice, especially where long heats or continuous running is desired.

There are many ideas suggested and a strong relation to be found in the principles involved in the distribution of stock illustrated in the cuts, Figs. 3, 4 and 6, going to prove that there are many things that work similarly in a furnace or cupola, and that a knowledge of the principles involved in the working of a furnace can ofttimes be well utilized by the founder, who in turn may present information of some value to a furnaceman.

Releasing Valve Gear with Dash Pot and Governor Control, Invented by Watt.

In the *Engineering Record* of March 30th, Mr. Edwin Reynolds, of Milwaukee, has a letter, accompanied by a sketch of a releasing gear for valves of steam engines, which shows a weight and dash pot. This, he says, was invented and built by James Watt. Mr. Reynolds also states that, at a later period, Watt connected tappets on the plug tree rod with a right and left-hand screw which was operated by the governor, "thus confining the inventions of Sickels and Watt to the particular method by which they accomplished the same results."

Edward Sanford, master mechanic at the Seth Thomas Clock Works, Thomaston, Conn., died of pneumonia the 20th inst. He was 38 years of age and leaves a wife and five children.

Car Fender.

We illustrate a new car fender, suitable for trolley or cable cars, the invention of W. A. Donor, 85 Hoboken avenue, Jersey City.

The main features of this fender are as follows: Fig. 1 is a side elevation with the guard *G* down, and Fig. 2 is a side elevation with the guard up after striking an obstruction. The lugs A^2 are riveted to the front A^1 of the car to which the fender is attached. The bars *B* and *E* are parts of its frame. The spring *K* is connected to the bar *E* and to the guard *G*; this guard is held down by the links *N*; the arms H^1 are secured to the guard *G* and support a helical spring *J* which extends across the fender. The netting is shown at *D*.

The action of the fender is as follows: The spring *J* is the first part of the fender which strikes an obstruction or a person; it is sufficiently yielding to reduce the force of the blow so as to prevent injury as much as

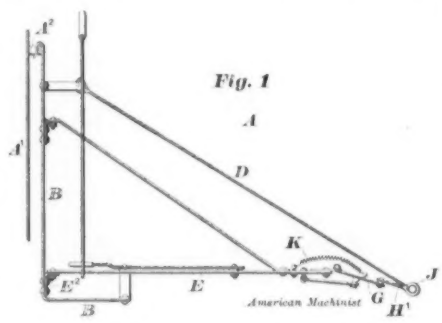


Fig. 1

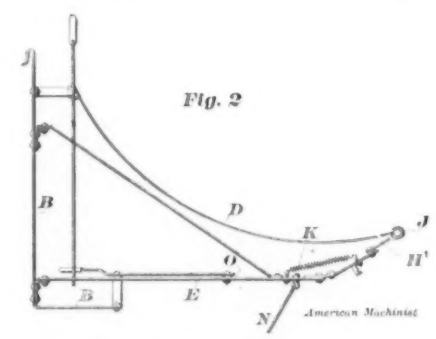


Fig. 2

possible to the person struck. When the spring *J* strikes an obstruction, the link *N* will drop and allow the spring *K* to raise the guard *G*, as shown in Fig. 2, and thus hold the obstruction in the netting *D*.

The other levers to which we have not referred, are for the purpose of turning the whole fender to the right or left so as to overcome the objection to projecting fenders colliding when cars are running in opposite directions over curves. This precautionary measure, however, may not be necessary on many roads.

American vs. English Lathes—American vs. European Castings.

Fancying that your correspondent writing about lathes in the March 28th number, may be anxious to know whether his shot at the man "who can see no good in anything unless it is foreign," has hit the mark, I beg to assure him that the arrow hit me square in the back, and has come through far enough in front so that anyone who is not afraid of pricking his fingers, can pull it out for further use.

There is an old saying "that if the coat fits," etc. Likely there is no more doubt in the minds of your readers as to who the shot was aimed at, than in the mind of your correspondent, and it is in order to consider the magnitude of the provocation.

To claim that a man can see good only in that which is foreign is, if nothing more, an implication that he is prejudiced, one-sided, or unfair. Let us see how the thing levels up. Your contributor in his closing paragraph says: "Let me add that while rigidity and power necessary to remove stock are essential in a high degree, does their importance, let me ask, outweigh the value of convenience, ease of manipulation and general adaptability to finish work a step beyond the roughing process?"

No doubt his reference to convenience is borrowed from my statement that "I knew of no piece of machinery that more nearly fills all the wants of our lathe man for handiness, than the New England slide rest and tool post." That would look as if I could see good in something besides foreign productions; it may occupy the time of your readers for a while, if they try to find anything in his communication, wherein he has said as much for any foreign production, or shown that he knows anything about it. Further in evidence, it may be well to look through the back columns of the American Machinist, and see how many complimentary things I have said about our own products, and question, if one, before imputing unfairness to another, had not better look to the truth and justice of his imputation, and further still see whether he himself is not the one who shows a weakness in that direction.

As regards the statement made through the private letter you quote from, wherein the traveler says he fails to find in France any of the wonderful work I wrote about some years ago, some words in explanation. Because one man sees things in a country or a place where another (however observant he may be) does not, is nothing to marvel over. It is likely a thousand German mechanics have visited this country without seeing the measuring appliances that Professor Beuleaux, of Berlin, described, and thereby aroused the indignation of his countrymen, who could have truly said they had been all over America and seen no such thing. How many of our mechanics, who went all through Machinery Hall at Chicago over and over again, who never saw the Creusot engine, or the wonderful steel casting cylinder head which stood beside it. This was eight or ten feet in diameter, two feet deep, cored to about ¾ inch thick, turned and finished on top, and turned on the bottom; the core holes left open so one could see the inside, where there was neither fins or chipping visible, certainly no paint or filling, and the whole thing without flaw or roughness. It is not likely to be disputed that such a casting was there, simply because several millions of people, who went all through Machinery Hall, did not see it.

As to a plain casting, the one shown at the Paris Exposition, fully described by Mr. Hemenway, was just as it came from the sand, with fins and all left on, no chipping, filing, filling, or paint. I am hardly willing to admit that I did not see it, or that there was any of this "all-that-glitters-is-not-gold" about it. As to the French workmen filing their castings all over, he certainly does not mean that all surfaces have the scale chipped off, and then the castings filed up. I say he does not mean it because they do not do it, in the sense that would imply; but what they do do at Creusot, and what they were doing at Steinlens, in Mulhouse, was to chip and file the castings until they conform to the design. If there are fins on, they chip and file until all evidence of them is gone, or so that when the filling and painting is done, all evidence of them is gone. If from a soft place in the sand there is a swell on the casting, they remove it in some way or in such a way that the evidence of its ever having been there is gone. Do we chip and file our castings? Certainly, and in exactly the same sense they do in France. Do we use iron filling? Certainly; every up-to-date shop in America, in exactly the same sense they do in France. Do we chip and file as perfectly or carry it to anything like the same extent, or, in other words, do we put an artist at the work, or a laborer? Maybe, but I have not seen it done in this country, and I did see it in France. We do exactly what they do, but I have not seen that work done anything like as well here as I saw it there.

As to the machining before painting, the outboard pedestal to the Corliss engine, which I said we Americans could not tell how it was made, was a duplicate of the regular George H. Corliss pedestal, copied with photographic fidelity, about five or six feet high and wide, and two feet or so thick. The main surfaces might have been machined all over with a profiling machine, but one that will cut a two-foot surface at a

single cut it is perfectly safe to predict does not exist in this country, and if there are any chippers who can carve and finish around the bosses and leave the thing so as to show no evidence as to where the machine left off and the chipping began, they are good ones. We could see no evidence of machine work, chipping, parting line, or filling; the corners were as square, sharp and true as if machined, which is hard to do with filling. In whatever way it was made it was equally wonderful.

The frame of the engine I have had occasion to mention, shown at Chicago by the same firm, and to which I took occasion to direct the attention of many visitors, called out various explanations from mechanics. One—the president of a prominent machine tool company—said it was just cast and dressed up, and that they had plenty as good castings in their yard. I took some pains to look over the castings in their exhibit, and failed to find anything of the sort there. Mr. Harris Tabor said, "the casting was just as it came from the sand; that the artist went at the mold and made it as he wanted the casting." If I know anything, I think I know the thing shown was not made of putty or filling. The superintendent of the company referred to above said they had no such casting in their yard, never did have, and that they could not make one.

As to the one casting known to have been machined before being painted and shown at the Paris Exhibition, I can say without much fear of contradiction, it was an American steam engine built by the Straight Line Engine Co., and the thing was done as much to demonstrate the capabilities of our traversing machine as to fix up an engine to compare favorably with what I knew it would have to compete with. We were able with the traversing machine to dress the sides and straight surfaces for less money than we could do a fair job any other way, but the French curves of the French work could not be done that way, or, if so, the machine that could do it would be worth seeing. None of us could express any more disgust at discovering this fraud than did the French engineer at Mulhouse.

Let us put the couplet this way. "For deeds that are dark and tricks that are vain," the French and the Chinese are not in it.

John E. Sweet.

An unique dinner was given by Mr. James Stokes, of New York, a few evenings ago, when he entertained nearly two hundred workmen who had worked upon his recently completed residence at the northwest corner of Park avenue and Thirty-eighth street. Mr. Stokes is, it seems, a student of sociology, and had promised himself years ago that when he built a house those who reared it should dine with him. The dinner is said to have been much enjoyed by all who participated in it, from hod carriers to electrical workers and decorators. The dinner itself was not, perhaps, of paramount importance, but if there was a great deal more of the spirit which prompted it, the world would be all the better place to live in.

NEW CATALOGS.

P. Pryibil, 512-523 West Forty first street, New York, sends us a pamphlet devoted to the illustration and description of machinery for wall paper manufacturers.

We have received from J. E. Snyder, Worcester, Mass., catalog illustrating and describing improved upright drilling machinery and accessories, such as drills, chucks, etc. The catalog is a neat and well-gotten up specimen, and is standard size (6″x9″).

We have received from Morarji V. Naik, Baroda, India, a copy of the "Indian Dyers' and Calico Printers' Diary and Year Book for 1895." This contains much useful and interesting information regarding the dyeing of textile fabrics in India, and is distributed gratis.

The Chicago Fire Covering Co., 48 Franklin street, Chicago, Ill., send us a general circular and price list, containing information regarding their covering for steam pipes, boilers, air pipes, etc. Different materials are used, including asbestos, magnesia, mineral wool, etc., and these are applied to all the purposes of heat insulation.

Messrs. L. Schutte & Co., Philadelphia, Pa., send us a pamphlet, illustrating and describing the Pa. torch, which is used for kindling fires in locomotives, furnaces, etc. It consists of a box containing oil, and provided with a pump by which a sufficient pressure of air is generated to spray the oil, and this spray when ignited and directed against the coal is sufficient to start a fire.

We have received from Chas. Churchill & Co., Ltd., 21 Cross street, Finsbury, London, E. C., England, their 1895 catalog of American machinery and tools, which is called "Engineering Supplement to the 1892 Catalog." This is a large and well-gotten up specimen, and contains engravings and descriptions of very many of the leading American machine tools, with most of which our readers are thoroughly familiar.

We have received from the Cleveland Punch and Shear Works Co., Cleveland, Ohio, an illustrated and descriptive catalog of punching and shearing machinery of all kinds, used in boiler, bridge and shipbuilding work. There are also some special drill presses adapted to work of this character, mixing machines, steam hammers, rotary planers, hydraulic wheels, tumbling barrels, and other special machinery. The catalog contains 140 pages, is well illustrated and printed, and is standard size (6″x9″).

We have received from the Morton Mfg. Co., Muskegon Heights, Mich., a catalog illustrating and describing their key-seating and other special machinery, draw-cut shapers, etc. The catalog contains a number of good illustrations, and is well printed on good paper, but it seems to us that it could easily have been 3/8″ shorter, which would have made it standard size (6″x9″). The construction of the cover of this catalog seems also to be a good one to be avoided by manufacturers. Instead of being continuous, *i. e.*, both the front and back made of one piece of paper, the front and back are made separately, and are joined by a pasted strip, and about the first thing that our copy did when we commenced to handle it, was to shed its cover in separate pieces.

MANUFACTURES.

The erection of a cotton-mill at High Point, N. C., is contemplated by H. F. Smith and others.

The Morse, Trussell & McLoon Company, of Rockland, Maine, will build an addition to their machine shop.

A company, in which H. E. Fries is interested, has been incorporated in Winston, W. Va., to erect a $100,000 cotton-mill.

The Warren Land and Lumber Company, of Warren, Texas, are extending their road into Polk Co., Texas, a distance of eighteen miles.

The Petroleum Iron Works, of Washington, Pa., will shortly erect a mammoth plant. The mill is to be equipped with modern machinery.

Very shortly, Messrs. Yonker & Winchester, of Eldora, Iowa, will start a factory for the manufacture of steel castings at the above-named city.

The Toledo Rolling Mill Co., of Toledo, Ohio, was recently organized, with a capital of $50,000. A. W. Houston, of Toledo, Ohio, is among those interested.

The R. S. Newbold Sons & Co., of Norristown, Pa., has taken possession of the Eagle Iron Works, and will enlarge the plant. J. D. Newbold is president.

The Sheffield (Ala.) Coal, Iron and Steel Co has been organized by Pennsylvania capitalists. They will erect their iron and steel department shortly at Sheffield, Ala.

It is proposed to organize a company in Hendersonville, N. C. About $150,000 capital stock has been subscribed. S. V. Perkins, of Hendersonville, N. C., is interested.

The Cleveland Punch and Shear Works Co., Cleveland, Ohio, have decided to erect an addition to their works, which will be 60 feet wide, 90 feet long, and 3 stories high.

The Southern Phosphate Works, of Macon, Georgia, recently burned, will rebuild their plant. Among the directors are J. E. Laidler, E. N. Jelks, Morris Happ and others.

The Clyde Steamship Co. have placed the order for their new pier shed with the Berlin Iron Bridge Co., of East Berlin, Conn. The building is 344 feet long and 124 feet wide, entirely of iron.

The Davenport, Clinton and Eastern Railway Co. has been incorporated, with a capital stock of $500,000. The company will build a line from Davenport to Clinton, Iowa, and the work on same will commence as soon as possible.

The Lehigh Valley Emery Wheel Co., Weissport, Pa., are putting upon the market emery wheels of a high grade, and state that with these they are making no attempt to compete with the so-called "cheap" wheels which are on the market.

The Chicago, Lake Shore and Eastern Railroad Company has been incorporated at Indianapolis, Ind., with a capital stock of $500,000, the incorporators being Chicago capitalists. The directors are W. G. Brimson, E. C. Crane, F. L. Ewan, J. S. Keefe and E. P. Prentice.

Arrangements have been made between the First National Bank of New York, owner of the Aurora City (Ill.) Railway Company, and the Elgin City (Ill.) Railway Company to consolidate and build a line from the two ends of Kane County, Ill. The capital stock will be $1,200,000.

E. M. Chapin, of Pine Meadow, Hartford, Conn., has received a large order for two-foot rules from England. They are to be specially broad rules, marked from left to right, instead of from right to left, as are American rules. The order will keep the full force of the shop at work for three months or longer.

Crescent Steel Co.

Crescent Extra

. . IS . .

The Steel so generally used now for Machine Shop Tools.

PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.

BUFFALO VENTILATING FANS
ELECTRIC, STEAM AND PULLEY TYPES, GREATEST AIR VOLUME, LEAST POWER
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

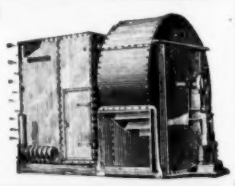
Chicago Office, 22 and 24 West Randolph Street.

PROGRESSIVE AND APARTMENT TYPES
BUFFALO LUMBER DRY KILNS.
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

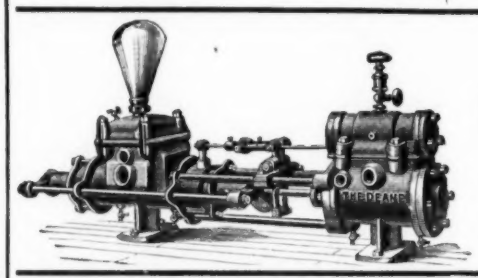
THE ENCYCLOPEDIA OF FOUNDING
BY
SIMPSON BOLLAND,
12mo, Cloth, - - - - - $3.00.
JOHN WILEY & SONS,
NEW YORK.

GRANT GEARS
Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St., Philadelphia, Pa.,
and 86 Seneca St., Cleveland Ohio.

HEAT YOUR WORKS
BY THE
"BLOWER SYSTEM."
FOR FULL INFORMATION AND ESTIMATES ADDRESS
B. F. STURTEVANT COMPANY,
Boston, New York, Philadelphia, Chicago, London, Eng.



BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.



THE DEANE
OF HOLYOKE
BOILER FEED PUMPS,
PISTON OR PLUNGER PATTERN.
THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
SEND FOR "THE DEANE SPECIALTIES."

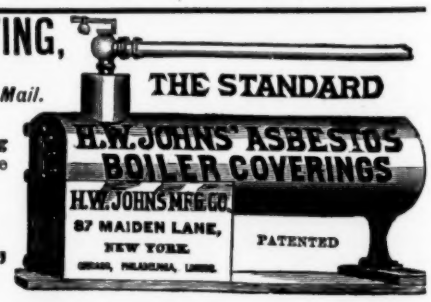
Finest Machine Relieved Taps and Adjustable Tap Wrenches
IN CASES.
SCREW PLATES, DIES, &C.
SEND FOR CATALOGUE.
WILEY & RUSSELL MFG. CO.,
GREENFIELD, MASS., U. S. A.

MACHINIST'S SET—TAP WRENCH & TAPS
TAP WRENCH No.4 - 19in. LONG AND MACHINE RELIEVED
TAPER, PLUG & BOTTOMING TAPS 3/8 TO 1in. - 21 TAPS.
LIGHTNING

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

"AYE, THERE'S THE RUB."
The price at which we are selling (not offering, but selling) our lathes and tools is causing surprise. We are prepared to turn out high-grade tools at very low prices; our profits are small, but we are satisfied, and we give satisfaction to our customers, so there's both profit and glory.
Our catalogue will tell you all about our lathes, planers, shapers, etc. Prices quoted on application.
SEBASTIAN LATHE CO.,
117 and 119 Culvert St., CINCINNATI, OHIO.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.



Mr. S. Ashton Hand has become a member of the firm of Pancoast & Hand, at 1213-15 Filbert street, Philadelphia. This firm's business is somewhat new—"Photographic Specialists," and they will deal in photographic supplies, and give advice and assistance in making suitable selections, especially where machinery is to be photographed.

The Hudson River and Cornell Railroad Company, of New York City, was incorporated to build and operate a railroad, ten miles long, from Croton-on-Hudson to Cornell, N. Y. Capital, $100,000. The directors are J. S. Coleman, C. J. Ryan, H. H. Brown, B. F. Coleman, C. J. Ryan, Jr., W. Kennelly, and J. B. Greene, of New York City, and Chas. Dayton, of Brooklyn, N. Y.

The Tradesman, Chattanooga, Tenn., in its review of the industrial conditions of the South for the week ending April 15, 1895, reports a decided improvement in general business, and a very evident change for the better in manufacturing circles. Iron, while not higher, is strong, and the demand is heavy. The lumber market also shows strength. The demand for machinery from all parts of the South is much heavier than for months, and there is a greater number of new projects than ordinarily.

The Billings & Spencer Co., of Hartford, are crowded with work, chiefly on bicycle and electrical machinery forgings. Sixty drop hammers are now running at full capacity in their works, and 190 men are employed. In one of the recent months, 17 tons of copper commutator bars were forged. They recently shipped to the American Axe Co., Cleveland, Ohio, a drop hammer of somewhat unusual dimensions, being 28 feet high, with a drop of 14 feet, the hammer (forged) weighing 1,600 pounds, and the anvil the same.

There has just been incorporated in Fresno, Cal., a company for the purpose of putting in an electric plant on the San Joaquin River, thirty miles from the above-named city. The works will be located near the river. The machinery, dynamos, etc., will be run by a Pelton wheel. It is the intention of the company to bring into that city by means of electric wires eleven hundred horsepower. They expect to supplant every steam plant in the city, as they claim to be able to furnish electric power for what the interest would be on a steam plant. The amount of water power obtainable on the San Joaquin River is almost unlimited. The company is already negotiating for the machinery, and expect to have everything running in about six months. The parties furnishing the money are supposed to be Chicago capitalists.

Machinists' Supplies and Iron.

New York, April 20, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $10.75 to $11.25 for No. 2; and $10.25 to $10.50 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.25 to $11 for No. 2; $10 to $10.50 for No. 3; $10.50 to $10.75 for No. 1 soft; $10 to $10.25 for No. 2 soft; and Foundry No. 4, $9.50 to $10.

Antimony—The demand for small lots has been fair, and the tone of the market seems to be a little firmer. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8½c. to 8¾c.; Hallett's, 7.10c. to 7.15c; U. S. French Star, 7¾c., and Japanese, 7c.

Lard Oil—Prime City we quote at 54c. to 55c.

Copper—The market is improving; the demand for good qualities is strong. Lake Copper is held at 9¾c., and Casting Copper is quoted at 9⅝c.

Lead—The demand is not strong, and sellers are indifferent. For New York delivery, 3.07½c. is quoted.

Spelter—The market remains steady, and the demand moderate. For New York delivery, 3.25c. is quoted.

Tin—The market is very firm, and prices have advanced. Jobbing lots have been sold at 14.25c. to 14.35c., and round lots at 14.05c. to 14.10c., net cash.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Competent mech. wants sit. as supt. or master mech; best references. E., American Machinist.

Foreman machinist, exp'd on medium and heavy work, desires to change. Box 135, Am. Machinist.

Pos. wanted as draftsm'n & designer, young man 28; tech educa'n; shop prac. Box 169, Am. Mach.

Mech. draftsman wants steady pos. 10 yrs' exp. good refs. Exp. in printing presses. Box 170, American Machinist.

Wanted—Pos. as supt. by a thorough mechanic of large exp. in modern shop management, build'g engines and heavy mach'y. Box 172, Am. Mach.

Wanted—A skillful draftsman, in an engine works. One who has been a patternmaker preferred. Address, with exp., Box 173, Am. Mach.

Wanted—Situation by exp'd machinist as general foreman or superintendent. Best of references. Address "Stanley," American Machinist.

Wanted—Foreman for machine shop. Capacity about 20 men. General jobbing a specialty. Steady job for good man. State experience, and wages expected. Address Box 174, American Machinist.

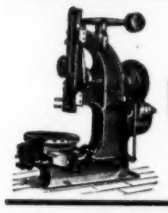
Practical machinist and draftsman 25 years' experience in large scale works as foreman and master mechanic, desires change; large exp. in special mach. and jigs to reduce cost. E. H. W., Am. Mach.

Graduate of leading technical school, 4 years' experience in shop, 2 years in drawing office, desires change—could invest $1,000. Address Box 175, care of American Machinist.

(*Continued on Page 334.*)

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

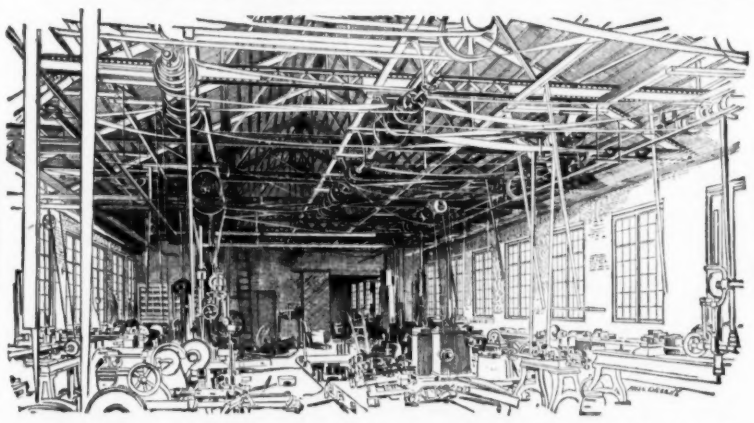
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



BETTS MACHINE COMPANY,
MACHINE TOOL BUILDERS,
WILMINGTON, DEL.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary

Engineers, Architects and Builders of

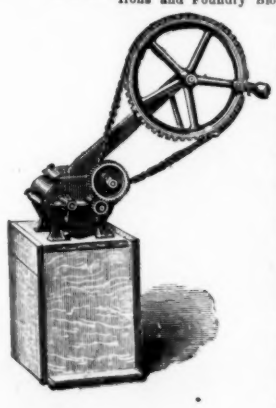


Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for The C. W. Hunt Co., at West New Brighton, Staten Island, New York. The building is 42 feet in width by 202 feet in length, and is used by the C.W. Hunt Co. as a Machine Shop. The side walls are of brick and the roof trusses of iron, with iron purlins covered with slate, so that no wood work is used about the construction of the building in any way, shape or manner, thus eliminating entirely the danger from fire. This is one of the best designed and equipped Machine Shops of its size in the United States.

SEND FOR OUR ILLUSTRATED CATALOGUE.

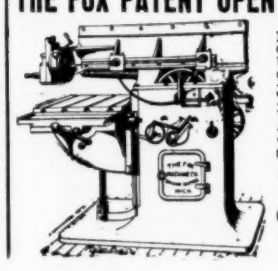
ROOTS' NEW ACME HAND BLOWER.
For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.



P. H. & F. M. ROOTS, Mfrs.
CONNERSVILLE, IND.
Chicago Office: 1405-10 MANHATTAN BUILDING.
COOKE & CO., Selling Agents,
163 & 165 Washington St., NEW YORK.
Please Mention This Paper.

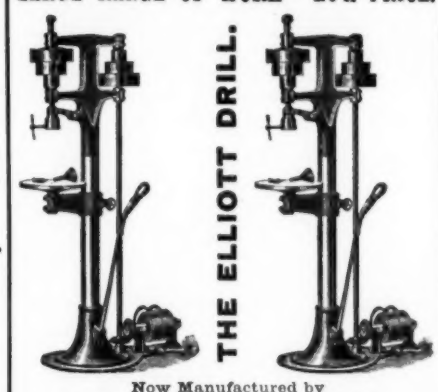
BOSTON GEAR WORKS
Frank Burgess, Prop., 35 Hartford St., Boston, Mass.
Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large.
Send for Catalogue. 1,100 sizes of Gears.

THE FOX PATENT OPEN SIDE SHAPER.



No springing of ram. No overhanging table. Quick Return, Stroke Under Perfect Control. Can be Instantly Adjusted 1-16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.
The Fox Machine Co.,
325 N. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England

The Elliott Drill Press
FOR ANY LIGHT WORK.
LARGE RANGE OF WORK—LOW PRICE.



Now Manufactured by
A. J. WILKINSON & CO.,
180 to 188 WASHINGTON ST., BOSTON, MASS.
SEND FOR CATALOGUE.

Star Lathes
Foot power
Screw Cutting
Automatic Cross Feed
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N.Y.

C. W. LE COUNT,
SOUTH NORWALK, CONN.

REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.60
4	3-4	.60
5	7-8	.70
6	1	.70
7	1 1-8	.80
8	1 1-4	.80
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

This Dog has a Very Heavy Boss, so that if the thread wears a Heavier Screw can be substituted.

Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.

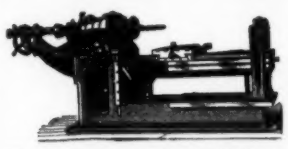
One Small Set of 8—by 1-4 inches to 20 inch, $6.35
One Set of 12—by 1-4 in. to 2 in. continued by 1 2 in. to 4 in. 13.35
These goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

THE BEST MECHANICS USE
MY VERNIER CALIPERS.
Ask your Dealer for them, or send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

J. T. SLOCOMB & CO.,
PROVIDENCE, R. I. U. S. A.

COMBINED DRILL AND COUNTERSINK
FOR CENTERING LATHE WORK.

FITCHBURG TOOLS.



Horizontal Boring and Drilling Machine.

FITCHBURG MACHINE WORKS,
FITCHBURG MASS.
SPECIAL MACHINERY
CONTRACTS. TRY US.

Engine Lathe, Swing 13 inches.

Send for CATALOG E.

BUILDERS IRON FOUNDRY,
Founders and Machinists,
PROVIDENCE, R. I.
GLOBE SPECIAL CASTINGS FOR WATER WORKS, MILLS AND RAILROADS.
The design presents numerous advantages. Odd shaped pieces are made without charge for pattern work.

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

TIME SAVED IS MONEY SAVED.
STYRIAN TOOL STEELS
will save you time in labor by wearing longer without resharpening.
HOUGHTON & RICHARDS,
SOLE AMERICAN AGENTS,
148 & 150 OLIVER ST., BOSTON.

WORTHINGTON CONDENSER.
ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

✻WANTED✻.

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

A young man with business ability, and some experience as draftsman, would like engagement with an engineering firm to learn their business. J. P. Lisk, 7-9 James St., Albany, N. Y.

Wanted—A prac. iron mach., competent to act as foreman and handle men in the iron department of an agricultural mach'y manufactory. Give exp., salary and refs. Whitman Agricultural Co., St. Louis, Mo.

Wanted—By a good, industrious, strictly temperate molder, a situation either as a molder, or to take charge of a small foundry making gen. work, employ'g from 1 to 6 men. A steady job more of an object than wages; references. X., Am. Mach.

Wanted—Two or three good machinists to work in shop, building hoisting and haulage engines; only first-class men wanted; a steady job and standard wages will be given suitable mechanics. Apply or address Kenney & Co., Scottdale, Pa.

Two men, one a supt. of many years experience, the other a cost and time clerk, want situation, taking charge of large machine shop, to introduce piecework system and practice economy in general. Box 166, American Machinist.

A thorough practical machinist and molder as general superintendent for a company employing 400 men, wishing to make a change, would like an interest with some other company; can produce good castings by a cheap mixture; will pay to investigate. Fox 160, American Machinist.

Wanted—A master machinist as foreman of a marine machine shop; he must have had a large experience and practice in shops engaged in building and repairing marine engines; must be proficient in drawing and accustomed and competent to make estimates on such work; pref. would be given to a person between the ages of 30 and 45; applicants may address Master, care of Amer. Mach., giving full reply to above with refs. if practicable.,

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Small tools cheap. Randall, 62 N. St., Spgfield, O.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—One or two good machinists to rent shop, and take the building of special machines by contract. Apply Box 171, American Machinist.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For Sale—A modern equipped machine shop located in Maryland; will accept 60 per cent. of purchase price for completing machines now in shop. Address Box 162, American Machinist.

Wanted—By up-to-date foreman & manager who will guarantee standard work at lowest cost of production, a position with some enterprising manufacturer who will appreciate ability and integrity. Address No Novice, care of American Machinist.

Wanted—The owners of a well-equipped foundry and machine shop, located within 30 minutes of New York, wish to enter into negotiations for the manufacture of specialties; also for their sale, if desired. Address, or call, 49 Wall street, Room 20, New York City.

Have $2,000 to invest, if desired, in manufacturing or jobbing machine shop; have long practical experience on printing presses, bookbinders' machinery, engines and general jobbing; had charge of men, and worked by contract, and can run all shop tools; age, 47; give some particulars. Address Box 176, American Machinist.

Established in 1874.

CLEVELAND TWIST DRILL CO.

COR. LAKE & KIRTLAND STS. CLEVELAND, O.

100 & 102 Reade Street, New York.
85 Queen Victoria St., London, Eng.
5 Neue Promenade, Berlin, C., Germany.

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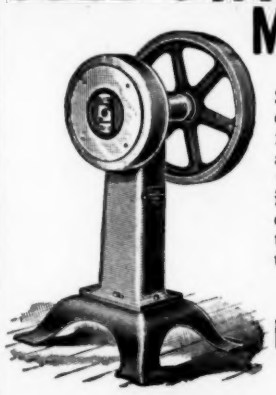

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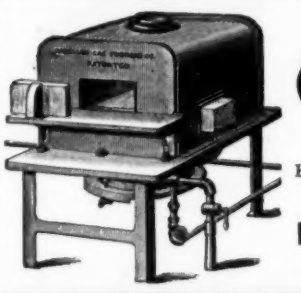

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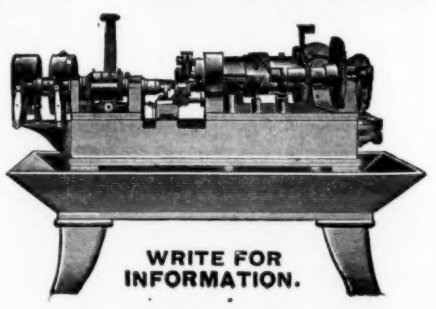

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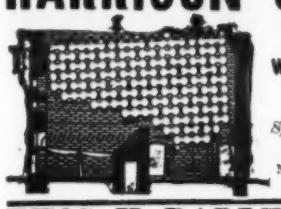

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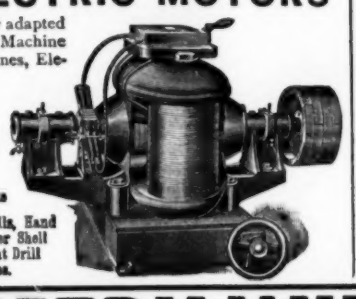

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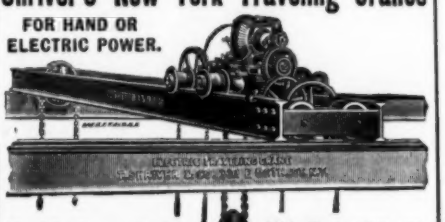

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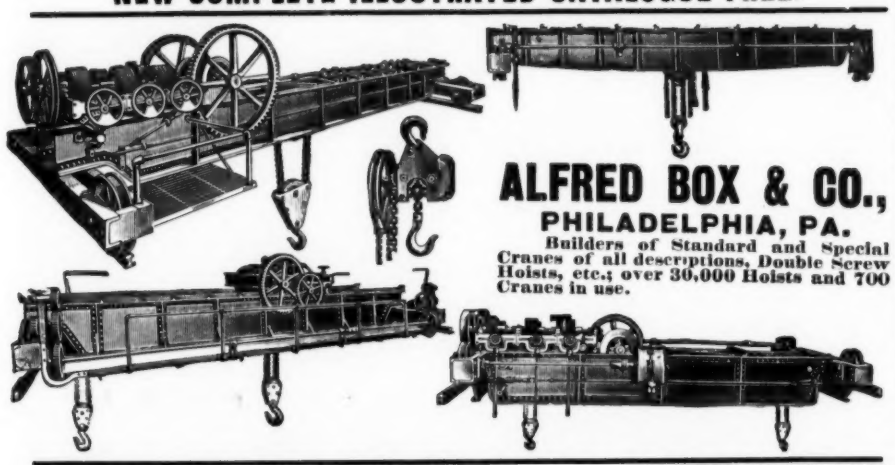

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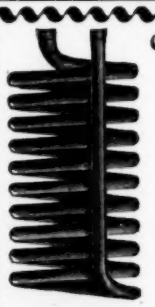

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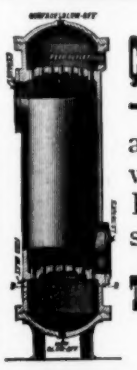

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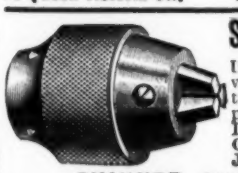

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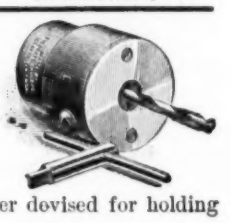

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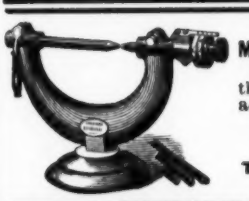

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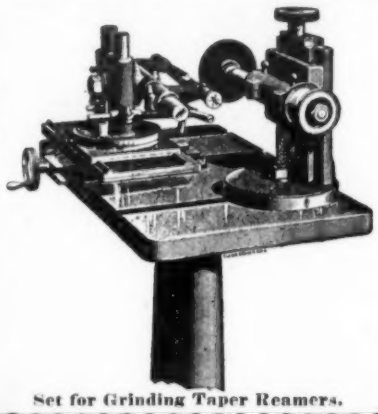

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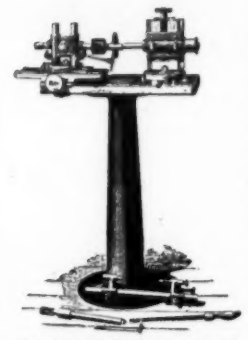

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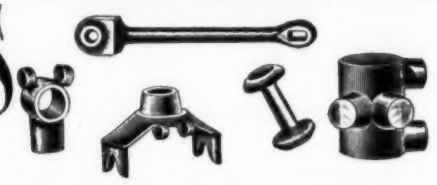

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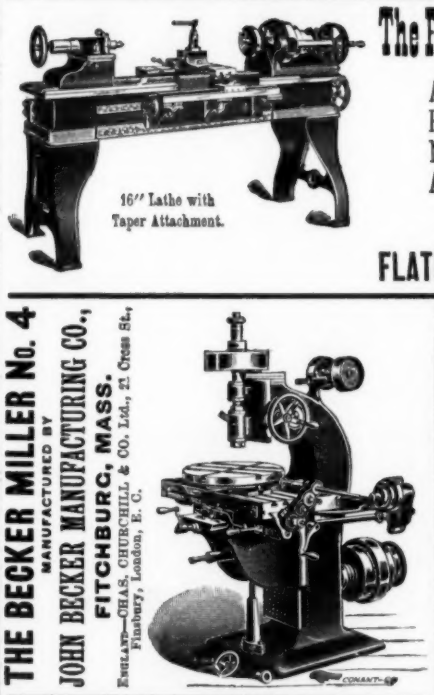

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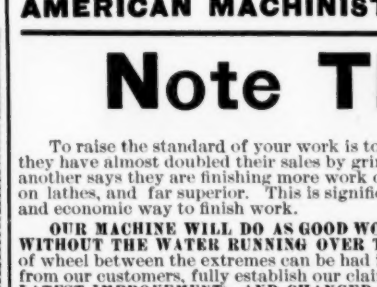

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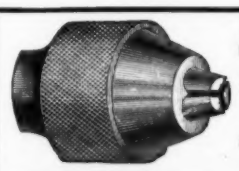

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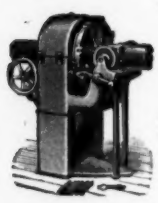

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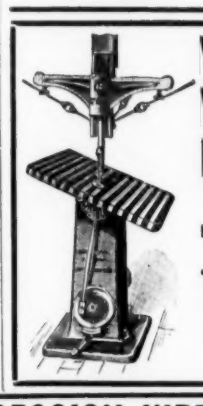

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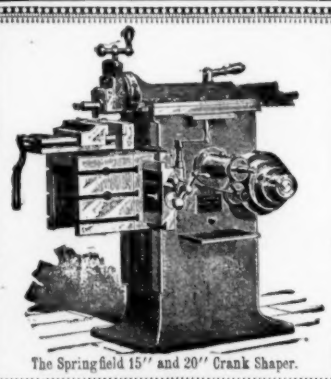

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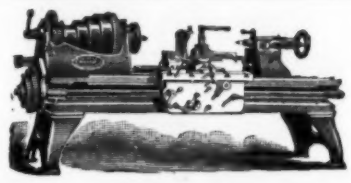

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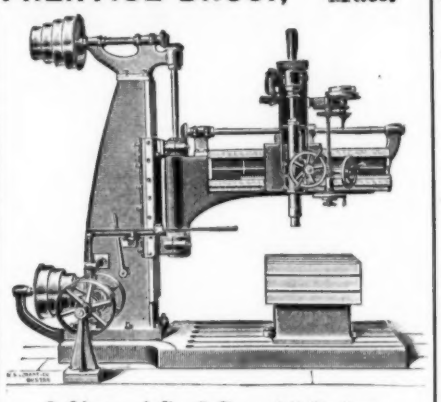

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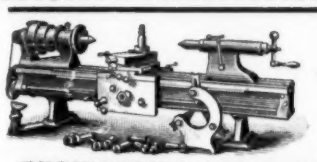

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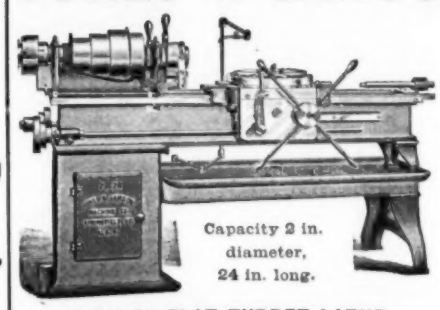

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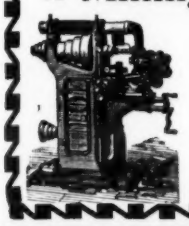

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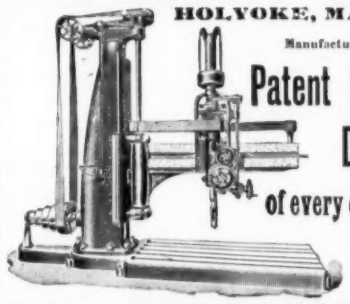

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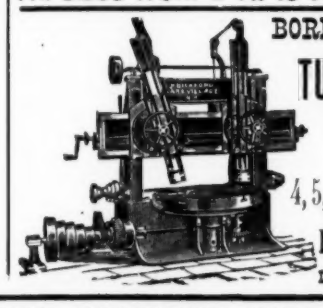

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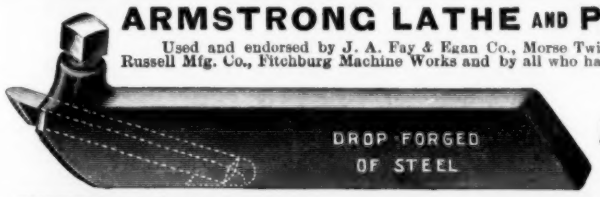

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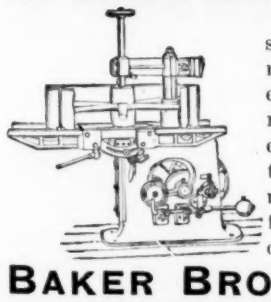

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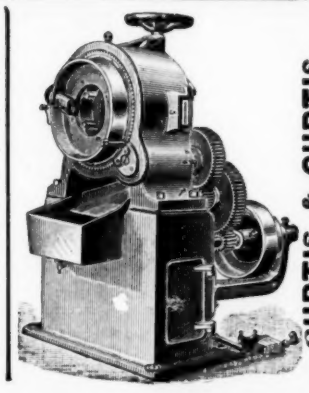

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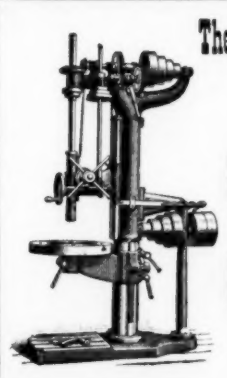

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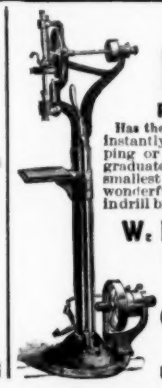

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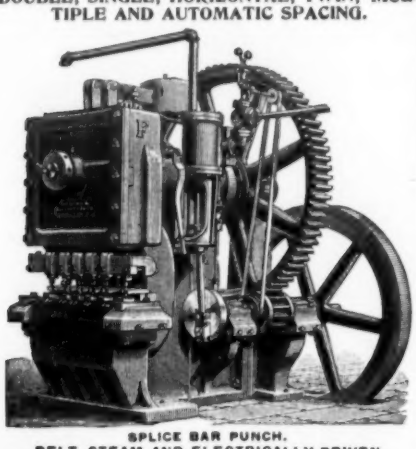

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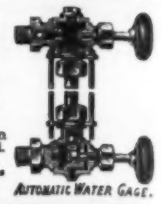

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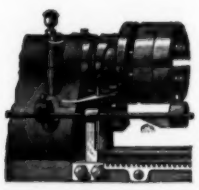

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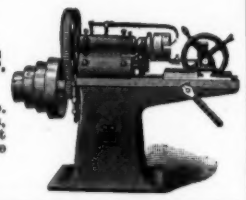

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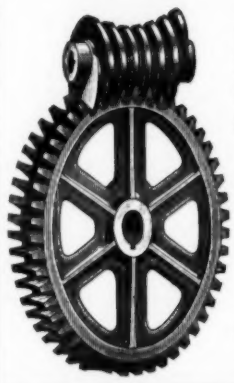

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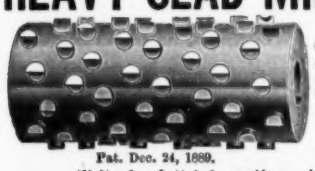

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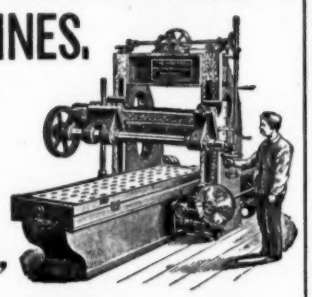

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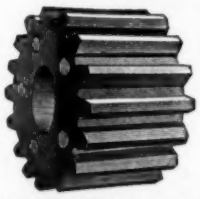

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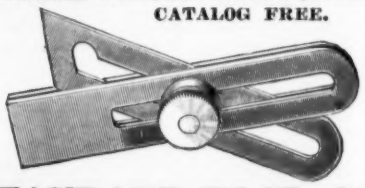

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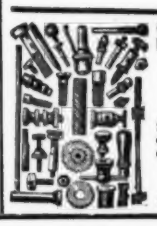

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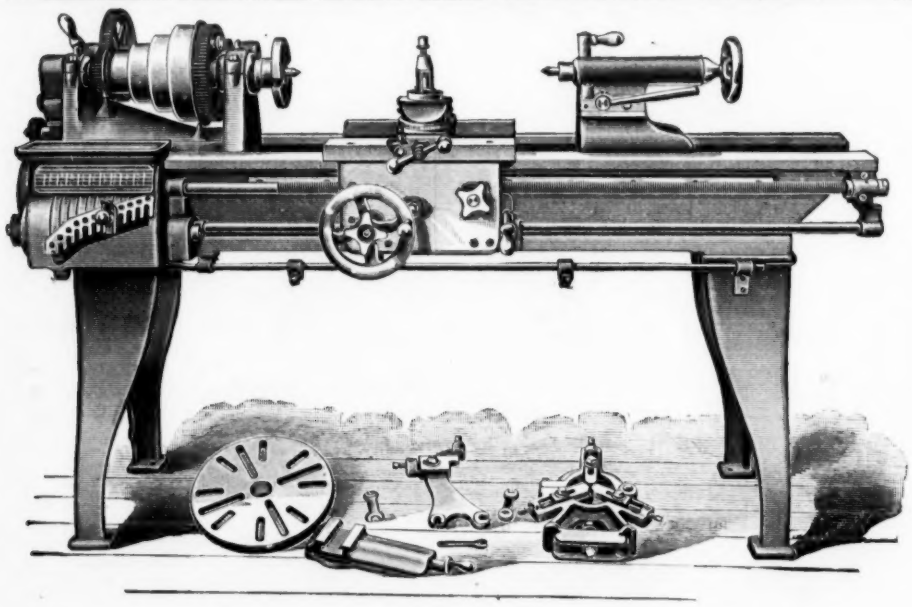

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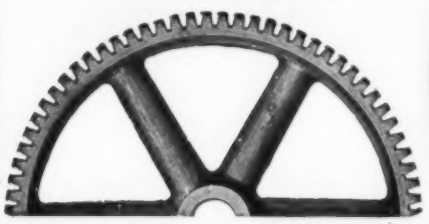

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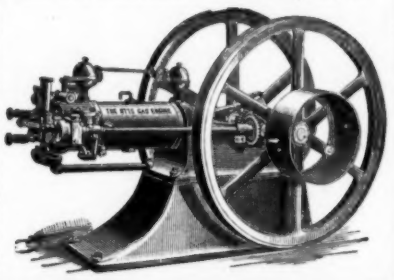

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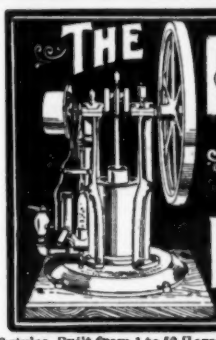

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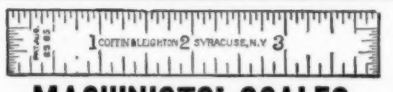

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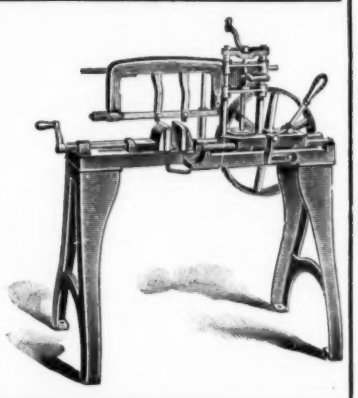

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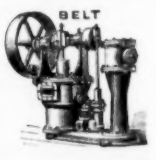

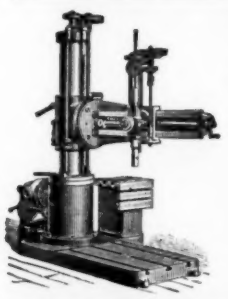

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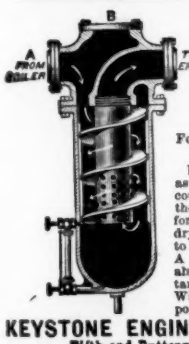

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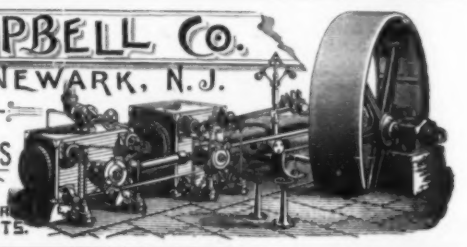

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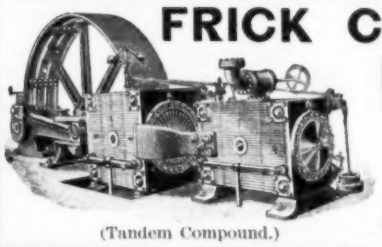

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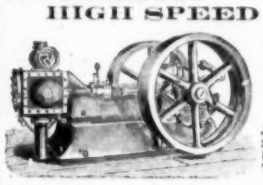

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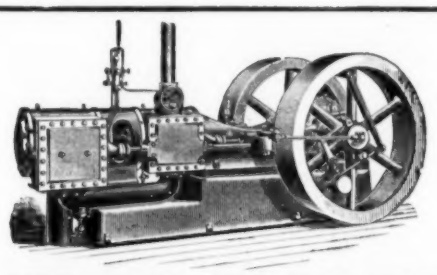

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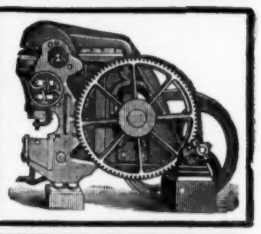

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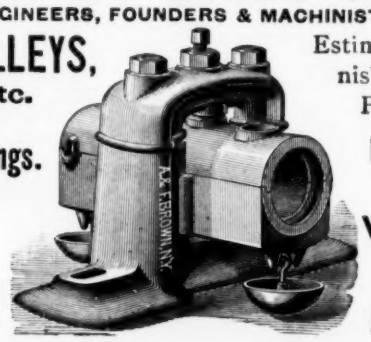

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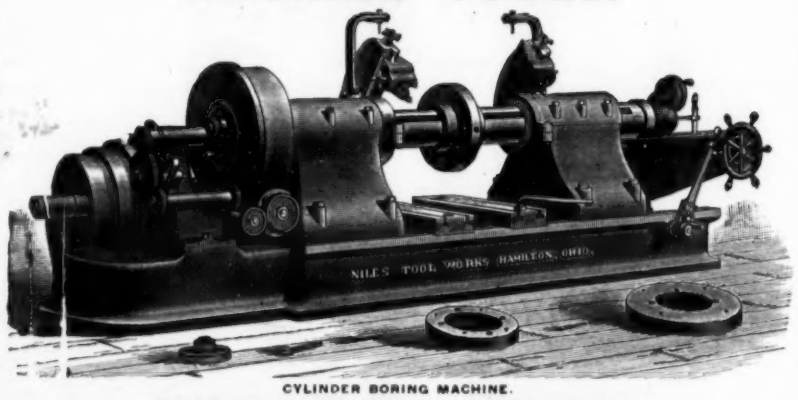

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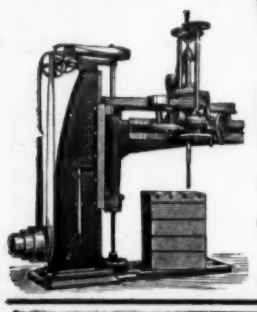

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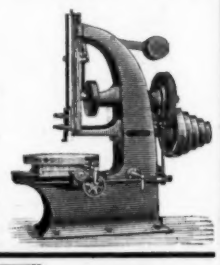

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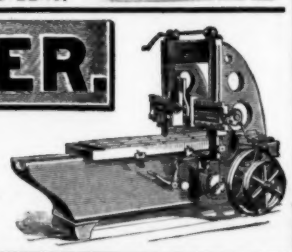

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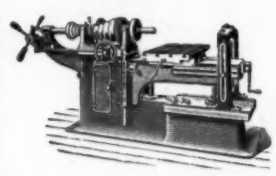

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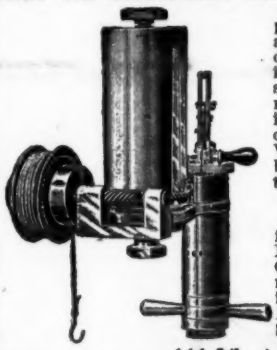

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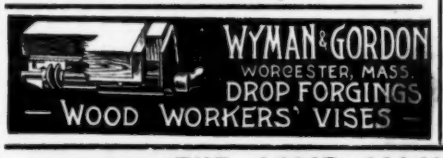

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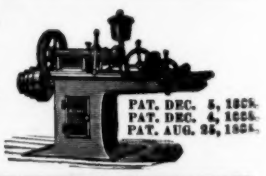
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single and Double Automatic
BOLT CUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.



WE have on hand for immediate delivery one Eight Spindle Automatic Drill for drilling bicycle parts. Will drill from ¼" diameter to 1¼" diameter. Send for cuts and description.

THE HENDEY MACHINE CO.,

TORRINGTON, CONN.

Manufacturer —of— TAPS & DIES